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GLYCOGEN PHOSPHORYLASE ISOENZYME BB AS A MARKER OF MYOCARDIAL STUNNING IN WATER POLO PLAYERS

GLIKOGEN FOSFORILAZA TIP BB KAO MARKER OŠAMUĆENJA MIOKARDA KOD VATERPOLISTA

Vjeroslava Slavić[1], Borislav Kamenov[2], Marina Delić[1], Sanja Bukilica[3], Tatjana Stanković[2], Milan Ćirković[4]

[1] Institute for Physical Medicine, Rehabilitation and Reumatology „Dr Simo Milosevic“ Igalo, Montenegro
[2] Pediatric Clinic Nis, Serbia
[3] Private Health Facility Meljine, Montenegro
[4] Military Medical Academy; Beograd; Serbia

Correspondence to:
Dr Vjeroslava Slavić
Sava Ilića 5,
85347 Igalo,
Crna Gora
Tel: 0038231658915
+382 69074244
to: vslavic@t-com.me
cc: mirelab@imi.bg.ac.rs

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Ključne reči
glikogen fosforilaza BB, vaterpolisti, „ošamućen“ miokard

Abstract

Background: In past years, several studies have suggested myocardial damage after extreme exercise due to increased post exercise levels of cardiac markers which return to baseline levels within 24 hours. Recently, the importance of the process labeled as myocardial “stunning” caused by ischemia or coronary vasospasm which is transient in nature and does not result in necrosis and permanent cellular damage has been emphasized. This study was performed to test if this extremely strenuous sport is hazardous to cardiovascular health of adolescent male water polo players. To this end, we measured serum concentration of the early marker of myocardial ischemia glycogen phosphorylase isoenzyme BB (GP-BB).
Methods: Total of 20 water polo players was studied. They were randomly divided in two groups: exercise group and non-exercise that served as a control group. GP-BB concentration was measured at different time points: basaline, and 1, 30 and 60 minutes following. exercise.
Results: Increased GP-BB concentration was found in 40% of water polo players in 1 and 30 minutes post exercise, but in only 10% one hour later. Obtained concentration 1 and 30 minutes following exercise significantly positively correlated ($r=0.895$;$p<0.001$) as well as concentrations at 30 and 60 minutes ($r=0.697$; $p<0.03$).
Conclusion: Glycogen phosphorylase isoenzyme BB could be a good marker of myocardial stunning caused by ischemia or coronary vasospasm which is transient in nature and does not result in necrosis and permanent cellular damage in water polo players.

INTRODUCTION

At present, the risk of myocardial damage by endurance exercise is under debate because of reports on exercise-associated increases in cardiac biomarkers which are typically elevated in patients with acute myocardial infarction and chronic heart failure [(1)]. Emerging evidence suggests that prolonged strenous exercise may be associated with „cardiac fatigue“ or „cardiac damage“, although the clinical implications remain obscure [(2)].

In recent years, special attention has been drawn to glycogen phosphorylase, specifically the BB isoenzyme (GP-BB) as a specific serum marker of myocardial ischemia [(3)]. This isoenzyme is present in human myocardium, in addition to the brain. Therefore, in the presence of an intact blood-brain barrier, serum GPBB is derived from the myocardium only [(4,5)]. This results in elevating of GPBB early in the blood within short time period of myocardial ischemia [(6,7,8)]. Moreover, preliminary human studies suggest a higher sensitivity of GPBB compared to other cardiac markers. Additionally, GPBB is not dependent on cellular death and necrosis for release, and thus is a true marker of ischemia [(9)].

Subject of our interest is water polo sport as the oldest continuous Olympic team sport. Water polo is a physically demanding sport; action is continuous, and players commonly swim three kilometres or more during four periods of play [(10,11,12)]. Therefore, in this study we examined if this extremely strenuous sport was hazardous to cardiovascular health of adolescent male water polo players.

MATERIAL AND METHODS

Total of 20 water polo players was studied. They were randomly divided in two groups. The first group was exposed to a strenuous exercise (exercise group) whilst the second group served as a control (non-exercise group). In order to avoid the selection bias, the groups were matched for age and level of physical stamina. Moreover, we examined only players from one team who trained under identical conditions. Blood samples (5 ml) from peripheral vein (cubital vein). blood samples were obtained at the following time points: baseline (before the exercise), 1 minute following the exercise (same in non-exercise group), 30 minutes following the exercise (same in non-exercise group) and 1 hour following the exercise (same in non-exercise group).). Serum was collected and stored in triplicate (at least 0.5 ml) aliquots with appropriate labeling and then were frozen (less than 25°C). The concentration of GP-BB was determined in duplicate by ELISA (Diagenics, USA). At the same time points measured blood pressure and heart rat were measured. Study was approved by the Ethical Committee of Faculty of Medicine University of Nis, Serbia.

All analyses were performed using the Statistical Package for the Social Science (SPSS), statistical software for Windows, Version 12.0 (SPSS Inc., IL, USA). The difference were assesed by Student's t-test and Perason's correlation test. Probability (p) less than 0.05 and 0.01 was considered significantly different and less than 0.001 highly significantly different.

RESULTS

Two analyzed groups, exercise and non-exercise, were matched in relation to age, body weight, body height, body mass index (BMI) and lenght of years in water polo sport. Mutual these two groups did not differ in mean value of diastolic and systolic blood pressure as well as heart rate frequency.

Basal concentration of GP-BB between groups did not differ significantly.

Exercise- induced changes in concentration of GP-BB were shown in figure 1.

One and 30 minutes following strenuous exercise 40% of water polo players had increased GP-BB concentration and

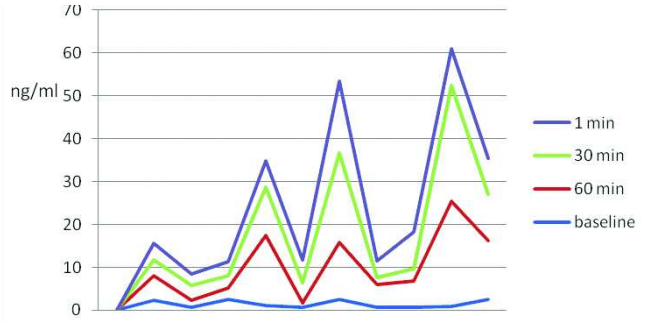

Figure 1. Exercise induced changes in concentration of GP-BB in water polo players

only 10% 60 minutes after. Strenous exercise induced a significant increase GP-BB concentration immediately after strenous exercise, precisely 1 minute after ($t=3.205$; $p<0.011$) in comparison to their basal values. Increased concentrations are maintained at the same rate in the next 30 minutes. Obtained concentrations following 1 and 30 minutes were in significantly positive correlation ($r=0.895$; $p<0.001$). In the next half hour GP-BB concentration is decreasing but still significantly positive correlation obtained between values 30 and 60 minutes following strenuous exercise ($r=0.697$; $p<0.03$).

None in the non-exercise group showed elevated concentration of GP-BB. Exercise did not induce statistically significant difference, although higher concentrations were obtained in comparison to non-exercise group.

We also analysed whether there was a connection between GP-BB concentration to the values of blood pressure and heart rate frequency. Our results indicate only a significant negative correlation to the diastolic pressure 1 ($r=-0.696$, $p<0.05$) and 30 minutes ($r=-0.644$, $p<0.05$) following exercise.

DISCUSSION

The question whether endurance exercise is associated with structural or functional damage of the human heart is of utmost importance for physicians involved in the medical care and guidance of endurance athletes. If myocardial damage occurs with prolonged exercise, this would result in the release of myocardial cellular proteins into the general circulation, where they can be detected [13]. In the past years, several studies have suggested myocardial damage after extreme endurance exercise due to increased post exercise levels of cardiac troponin I and T, natriuretic peptide (BNP), ischemia modified albumin (IMA), glycogen phosphorylase isoenzyme BB (GPBB), creatinin kinase MB (CK-MB) which returned to baseline values within 24 h [14,15,16,17]. Recent studies, particularly emphasize the importance of the process labeled as myocardial "stunning" caused by ischemia or coronary vasospasm [18] which is transient in nature and does not result in necrosis and permanent cellular damage [13].

According to published studies, GP-BB was highly specific and highly sensitive marker of early myocardial ischemia indicating ischemic "minimal" myocardial damage at an early stage [6,7,8]. Its release requires both, burst in glycogenolysis and concomitantly increased plasma membrane permeability (19). Nevertheless, there are a few studies examining exercise- induced myocardial ischemia in competitive sports by measuring the concentration of GP-BB, particularly in water polo sport. According to the literature, GP-BB concentration increases immediately after strenuous exercise like 21 km run, cross country running or cycling [17,20,14]. One minute following strenuous exercise 40% of water polo players showed elevated GP-BB concentration. Although there is comprehensive information on traditional biomarkers of cardiac damage following exercise, less is known on the kinetics of innovate markers, including GP-BB. Thus, 21 km run causes significant increase in GP-BB concentration immediately after running and returns to baseline values 6 hours after [17]. In our study, we analyzed the dynamics in first hour following strenuous exercise. According to our results, 40% still had increased GP-BB concentration after 30 min, and only 10% after 60 min. Osbakken and Locko employed stress-redistributed thallium scans and reported possible evidence of myocardial perfu-

sion defects in trained athletes after 40±7 minutes of fatigue-limited sub maximal bicycle exercise [21].

Concerning the structure of water polo players motion during game, 35% of overall time the players is in quasi-horizontal phase (all swimming at all levels of intensity during game), whereas the remaining 65% of the time in quasi-vertical phase (vertical position achieved by leg work known as water polo cycling) [22]. Myocardial blood flow is stopped or greatly reduced during systole based on contractile force so that during exercise coronary perfusion in diastole increases due to a dramatically increased intravascular pressure [23]. GP-BB concentrations were in significant, negative correlations with diastolic blood pressure in 1 and 30 minutes following strenuous exercise.

CONCLUSION

Glycogen phosphorylase isoenzyme BB could be a good marker of myocardial „stunning" caused by ischemia or coronary vasospasm which is transient in nature and does not result in necrosis and permanent cellular damage in water polo players.

Sažetak

Uvod: Poslednjih godina objavljene su studije u kojima je ukazano da nakon napornog vežbanja nastaje oštećenje miokarda na osnovu povišenih koncentracija biohemijskih srčanih markera odmah nakon vježbanja, a koje su se vraćale u referentne opsege unutar 24 sata. U skorije vrijeme posebnu pažnju privlači fenomen označen kao "ošamućeni miokard" koji je uzrokovan ishemijom ili vazospazmom. Prolaznog je karaktera i nije praćen nekrozom i trajnim ćelijskim oštećenjima miokarda. Ovo istraživanje je sprovedeno sa ciljem da se ispita da li je ovaj izuzetno naporan sport opasan za kardiovaskularni sistem u zdravih vaterpolista kroz određivanje koncentracija glikogen fosforilaze izoenzima BB (GP-BB) kao ranom markeru ishemije miokarda.

Metode: Studija je obuhvatila 20 vaterpolista koji su nasumično podijeljeni u dvije grupe: (1) izložena napornom treningu i (2) kontrolna, bez treninga. Koncentracije GP-BB su određivanje: bazalno, 1, 30 i 60 minuta nakon treninga.

Rezultati: Povećane koncentracije GP-BB imalo je 40% ispitanika 1 i 30 minuta nakon treninga, odnosno 10% poslije 60 minuta. Dobijene koncentracije su bile u značajnoj pozitivnoj korelaciji između 1 i 30 minuta ($r=0.895;p<0.001$), te između 30 i 60 minuta ($r=0.697$; $p<0.03$).

Zaključak: Glikogen fosforilaza izoenzim BB mogao bi da bude značajan marker „ošamućenja" miokarda uzrokovanog prolaznom ishemijom ili vazospazmom koji nije praćen nekrozom i trajnim ćelijskim oštećenjem.

REFERENCES

1. Scharhag J, George K, Shave R, Urhausen A, Kindermann W. Exercise-associated increases in cardiac biomarkers. Med Sci Sports Exerc. 2008;40:1408-15
2. Green DJ, Naylor LH, George K. Cardiac and vascular adaptations on exercise. Curr Opin Clin Nutr Metab Care 2006;9(6):677-84
3. Apple FS, Wu AHB, Mair J, Ravkilde J, Panteghini M, Tate J, Pagani F, Christenson RH, Mockel M, Danne O, Jaffe AS. Future biomarkers for detection of ischemia and risk stratification in acute coronary syndrome. Clin Chem 2005; 51:810-824
4. Rabitzsch G, Mair J, Lechleitner P, Noll F, Hofman U, Krause EG, et al. Immunoenzymometric assay of human glycogen phosphorylase isoenzyme BB in diagnosis of ischemic myocardial injury. Clin Chem 1995; 41:966-78
5. Newgard CB, Hwang PK, Fletterick RJ: The family of glycogen phosphorylases: structure and function. Crit Rev Biochem Mol Biol 1989; 24:69-99
6. Mair J, Puschendorf B, Amidy J, Lechleitner P, Dientstl F, Noll F, Krause EG, Rabitzsch G. Early release of glycogen phosphorylasae in patients with unstabile angina and transient ST-T alterations. British Heart Journal 1994; 72:125-127
7. Peetz D, Post F, Schinzel H, Schweigert R, Schollmayer C, Steinbach K, Dati F, Noll F, Lackner KJ. Glycogen phosphorylase BB in acute coronary syndromes. Clin Chem Lab Med 2005; 43: 1351-1358
8. Mair P, Mair J, Krause EG, Balogh D, Puschendorf B, Rabitzsch G. Glycogen phosporylase isoenzyme BB mass release after coronary artery bypass grafting Eur J Clin Chem Clin Biochem 1994; 32: 543-547
9. Kemp M, Donova J, Higham H, Hooper J. Biochemical markers of myocardial injury. British J Anaestesia 2004; 93:63-73
10. Barr D. A Guide to Water Polo, Sterling Publishing (London) 2001: pp 23-25
11. Smith, Heather. "Applied Physiology of Water Polo." Sports Medicine. 1988:317:34.
12. Marion A, Honish A. Coache´s Infoservice, sports science information for coaches: The Water Polo Shot Retrieved Decembar 17, 2006
13. Dawson E, George K, Shave R, Whyte G, Ball D. Does the human heart fatigue subsequent to prolonged exercise? Sports Med 2003; 33(5):365-380
14. Williams K, George K, Hulton A, Godfrey R, Lahart I, Wilson MG, Charlesworth S, Warburton D, Gaze D, Whyte G. A unique case series of novel biomarkers of cardiac damage in cyclists completing the 480km race across america (RAAM). Curr Med Chem 2011;14: 21756241
15. Whyte GP. Clinical significance of cardiac damage and changes in function after exercise. Medicine & Science in Sports & Exercise 2008;40(8):1416-1423
16. Neumayr G, Pfister R, Mitterbauer G, Eibl G, Hoertnagl H. Effect of competitive marathon cycling on plasma N-terminal pro-brain natriuretic peptide and cardiac troponin T in healthy recreational cyclists. Am J Cardiology 2005;96(5):732—735
17. Lippi G, Schena F, Montagnana M, Salvagno GL, Guidi GC. Influence of acute physical exercise on emerging muscular bomarkers. Clin Chem Lab Med 2008;46(9):1313-8
18. Starnes JW, Bowles DK. Role of exercise in the cause and prevention of cardiac dysfunction. Exerc Sport Sci Rev 1995;23:349-74
19. Krause EG, Rabitzsch G, Noll E, Mair J, Puschendorf B. Glycogen phosphorylase isoenzyme BB in diagnosis of myocardial ischaemic injury and infarction. Mol Cell Biochem 1996:160-161:289-95
20. Zhing JJ, Cheng JK, Yu M, Li PF et al. Effects of cross-country running during empty stomach on the serum levels of glucose and fatty acid, glycogen phosphorylse isoenzyme BB and heart-type fatty acid binding protein. J Med Postgraduate 2010-03
21. Osbakken M, Locko R. Scintigraphy determination of ventricular function and coronary perfusion in long-distance runners. Am Heart J 1984;108:296-304
22. Lozovina M, Đurović N, Katić R. Position specific morphological characteristics of elite water polo players. Coll Antropol. 2009;33(3):781-789
23. Bolli R, Patel BS, Hartley CJ, Thornby JI, Jeroudi O, Roberts R. Nonuniform transmural recovery of contractile function in stunned myocardium. Am J Physiol 1989; 257:H375-H385

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