World Applied Sciences Journal 5 (5): 571-575, 2008
ISSN 1818-4952
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The Effect of a Submaximal Swimming Program on Plasma ANP Concentration and its Relationships with Essential Hypertension in Middle-age Males

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Abstract: The purpose of this study was to investigate the effect of a selected submaximal swimming training on BP and plasma [ANP] among middle age males with EH. In this research, 30 subjects aged 40-55 years with mild EH for at least 2 years, were selected. The subjects were randomly divided into EXP and CON groups. The CON group were asked to continue their normal life but were closely observed. The EXP group was guided to participate in training protocol for 28 sessions, 3 days a week. In each session subjects were asked to swim at 60-65% of Maximum pulse rate for 55 to 60 min. The Bruce treadmill test was conducted to determine the aerobic capacity of subjects. The Doppler M. Mode Echocardiography test showed that subjects had no problems to participate in training protocol. Pulse rate was used to control the training intensity. Sys and dia BP of each EXP subject was measured before and after training session and blood samples were taken at four stages, before training started, 30 min, 24 h and two weeks after last training session. [ANP] was also measured by RIA method. The t-test, ($P<0.05$), was used to test the hypotheses. The findings are as follows: In EXP group there was a significant difference between sys and dia BP before and after each session. There was also a significant difference between [ANP] in EXP group before training started, 30 min, 24 h and 2 weeks after the last training session. In addition, there was significant differences between sys and dia BP and [ANP] of EXP group before training started and 24 h after the last training session. The results revealed that following a submaximal swimming training protocol, the sys and dia BP would decrease to safe border which might be due to the increase of [ANP].

Key words: ANP · Exercise · Hypertension

INTRODUCTION

Many people are suffering from Essential Hypertension (EH) which is the cause of a considerable portion of deaths. During past years, Physicians have used different pharmacological methods to control the hypertension but, still the main cause of EH and exact method to control it, is not clear. One effective mechanism on the changes of blood pressure (BP) refers to the role of Atria Natriuretic Peptide (ANP). ANP is a hormone, mainly released form cardiocytes in response to local wall stretch. It reduces blood pressure (BP) and intravascular volume by promoting diuresis and natriuresis, relaxation of vascular smooth muscles, transuduction of plasma water to interstitial fluid and by inhibition of aldosterone, rennin, vasopressin and norepinephrine release [1]. Preclinical evidence exists for the anxiolytic activity of ANP, which is released during lactate-induced panic attacks [2].

Physical activity has been considered as an effective treatment to improve the function of the cardiovascular system and inhibition of the increment of systolic blood pressure in EH patients. However, there is argument on characteristics (intensity, volume, frequency) of an effective training protocol. Also, the role of ANP-as a biochemical/ heamodynamical index of BP responses to exercise training-is not clear, yet [2-4].

Therefore, the aim of present study was to reveal if submaximal swimming exercise could modify the BP profile of mild EH patients, through the changes of plasma ANP concentration. Physical exercise is known to have influences on the plasma concentration of ANP in dog [1],

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horse [5] and human [4,6-7] and many researchers have reported on the relation between exercise, ANP and regulation of BP [4-5,7].

MATERIALS AND METHODS

Subjects: Thirty male, mild EH patients, aged 40-55 years, agreed to participate in the study. They were divided to two matched groups as experimental (EXP, N=15) and control (CON, N=15) groups.

Exercise Training Protocol: Before starting the exercise training program, 65% of HR_{max} of subjects was determined by exercise testing and ECG. Exercise training protocol included 29 sessions of submaximal swimming. The intensity of exercise was set about 65% of HR_{max} of each subject and rest period was decreased progressively so that after 15 sessions, subjects were able to swim for 55-60 min only with short time periods of rest.

BP and ANP Measurements: Ten minutes before and after each training session, systolic (sys) and diastolic (dia) BP was measured. Blood samples (10cc) of EXP group were collected one day before starting exercise protocol and 30 min, 24 h and two weeks after last exercise training sessions. Blood samples (10cc) of CON group were collected one day before starting training protocol of EXP group and one day after the end of training period of EXP group. The concentration of plasma ANP was measured by radio immunoassay (RIK 9105, B (Human), Peninsula Lab, CA, USA).

Statistics: Statistical calculations were carried out with dependent t-tests. The zero hypothesis was rejected when $P<0.05$.

RESULTS

The results of this study are presented in Table 1-3. There was no significant difference between EXP and CON groups, concerning their Age, Height, Body weight and BP before starting exercise training protocol (Table 1).

Systolic Blood Pressure and Diastolic Blood Pressure: The findings of this study indicated that systolic blood pressure of EXP group was decreased following exercise training as its mean was 15.68±1.56 mmHg (1^{st} session), 15.636±1.30 mmHg (2^{nd} session), 14.04±1.14 mmHg (12^{th} session) and 13.45±1.36 mmHg (28^{th} session) as presented in Table 2. Dependent t-test showed that mean sys BP of EXP group for 2^{nd}, 12^{th} and 28^{th} sessions were significantly different compared to 1^{st} session ($P<0.003$, $p<0.001$, respectively, Fig. 1).

The above mentioned comparison was also done concerning dia BP of EXP group, which revealed that it was decreased following exercise training so that there was significant difference between dia BP of subjects in 1^{st} and 2^{nd} ($p<0.013$); 1^{st} and 12^{th} ($p<0.01$) and 1^{st} and 28^{th} ($p<0.006$) sessions (Table 2).

In addition, difference between BP of EXP group 10 min before starting each exercise session and at the end of same session was measured for all 28 sessions. It was also indicative of effectiveness of exercise training, as for all sessions the difference between mean values of BP (both sys and dia), before and after each session was significant (data not shown).

There was no significant difference between mean values of BP (both sys and dia, $P=0.512$ and $P=0.69$,

Table 1: Age, Height and body weight of Experimental (EXP) and control (CON) groups

	EXP	CON
Age(year)	46.09	47.22
Height (cm)	170.55	169.56
Body weight (kg)	77.27	78.11

Table 2: Mean Values (mmHg) of Systolic (sys) and diastolic (dia) blood pressure of two groups before and after exercise training protocol

Session of training	Blood pressure	EXP. group Before	EXP. group After	CON group Before	CON group After
2^{nd}	sys	15.636	14.682	*15.389	---
	dia	10.591	10.00	**10.722	---
12^{th}	sys	14.045	12.909	---	---
	dia	9.545	8.909	---	---
28^{th}	sys	13.455	11.955	---	*15.500
	dia	9.227	8.909	---	**10.833

* and ** : Not significant

Table 3:Mean values of the Concentration of plasma ANP (pg)

	EXP	CON
Before starting		
Exercise training Protocol	8.885	9.183
30 min after last session of training	*9.927	-
24 h after last session of training		
*9.905	-	
2 weeks after last session of training	*11.332	† 8.995

* Significantly different, compared to before starting exercise,† Not significantly different compared to before starting exercise protocol

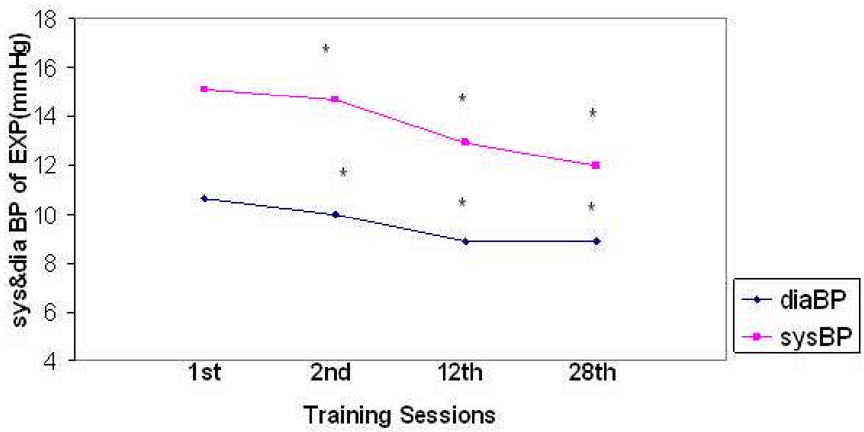

Fig. 1: Changes of Blood pressure of EXP group in different training sessions
* Significantly different comparing to 1st session

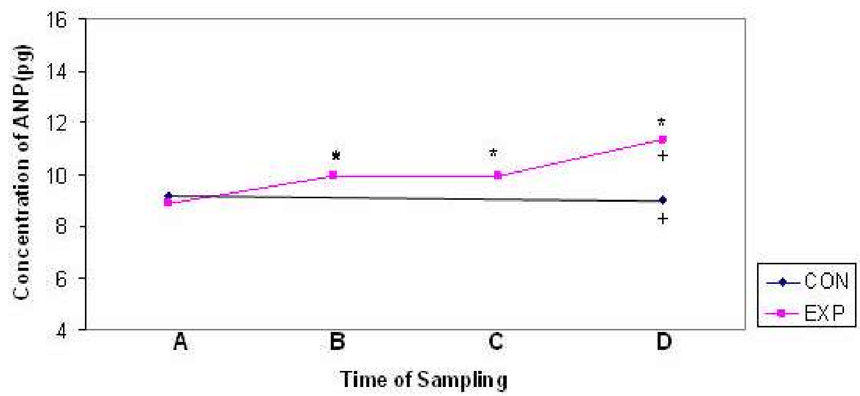

Fig. 2: Changes of ANP concentration in experimental (EXP) and control (CON) groups. A, before starting the first session of training ; B,C and D includes 30 min, 24 h and 2 weeks after last session of training , respectively,* Significantly different, compared to A among EXP and + not significantly different

respectively) of CON group, comparing 1st session to 28th session; while same comparison for EXP group showed significant changes (Table 2.) Finally, the main finding of this research was about the changes of concentration of plasma ANP. As it is presented in Table 3, there was no significant ($P=0.374$) changes between concentration of plasma ANP of CON group, before starting exercise training protocol by EXP group (9.183pg), compared to two weeks after 28th sessions of training protocol (8.995pg).

There were, however, significant difference between concentrations of plasma ANP of EXP group when mean values of 30 min (9.927pg), 24 h (9.905pg) and 2 weeks after last session (11.332pg) were compared to mean value (8.885pg) of before starting 1st session of training protocol ($P<0.028$, $P<0.021$, $P<0.001$, respectively-Fig. 2).

DISCUSSION

Findings of present study showed, generally, that a submaximal swimming training program affected the physiological and functional indices of cardiovascular system of mild hypertensive middle-aged men. Also the main result of this study revealed that the selected training protocol increased the concentration of plasma ANP of subjects, which lasted up to 2 weeks after last session of exercise training. Results of this experiment in relation with increased ability of subjects for swimming and their decreased training heart rate (not shown); and positive changes of their BP profile are supported by others [2, 4, 6]. The mechanisms such as improved pumping of blood by heart, decreased resistance in vascular system, optimal blood distribution and more uptake of oxygen by muscles could explain these changes [2, 4]. It was also found that concentration of plasma ANP increased following 29 sessions of submaximal swimming. This result is in accordance with data from others who have demonstrated that marathon race caused a two-and-a-half fold increase in plasma ANP concentration [6,8].It has also been shown that after short maximal exercise performed on a cycle ergometer, plasma ANP concentration increased five fold [9] or three-and-a-half fold [10].

In healthy humans [11-12] and in heart-transplant recipients [13], ANP has been shown to increase during and following exercise. Increase in atrial pressure [14], increase in atrial stretch secondary to increased venous return [13,15] exercise-induced increase of catecholamines [16] are among factors proposed to explain ANP hypersecretion during exercise.

In a study, two different models of physical activity were employed as non pharmacological therapy of men with mile hypertension. The results demonstrated that plasma ANP was increased 23% and 77% after pedaling on cycle ergometer and working with hands and there was a correlation between plasma ANP changes and changes of some cardiovascular indexes such as heart rate, left ventricular volume and systolic blood flow [17]. However, Beliveau et al. [2] reported that changes in heart rate and in catecholamine concentrations did not appear to play a major role in the control of ANP release in atrioventricular blocked-dogs after a 10-minute treadmill exercise bout of mild intensity. Lijnen et al. [14] demonstrated marked elevations of plasma ANP 36 h and 7 days after a marathon run and attributed this to plasma volume changes. but according to others [18-20] ANP decreases during the recovery period to control values and does not seem to influence on the plasma volume.

It seems that the knowledge concerning the role of ANP and its second messenger, Guanosine cyclic monophosphate and its relation/interaction with other regulating hormones/plasma proteins for homeostasis of plasma volume, after prolonged physical exercise, is scant [5,8]. However, in our study [ANP] had increased 30 min, 2 h and two weeks after last session of a long term training protocol. Considering the effective diuretic role of ANP under the conditions of subjects of present study, it might be assumed that training-induced changes such as improved function of cardivasular system and muscle oxygen uptake nessecitates the ANP hypersecretion, which all-together could be considered as non pharmachological treatment of mild hypertension.

Water intake, urinary output, changes of other volume-regulating hormones and mRNA of ANP were not examined in present experiment. A comprehensive study in future including all these factors may give insight to better understanding of therapeutic role of exercise-induced plasma ANP in hypertension.

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