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Effects of new sports tennis type exercise on aerobic capacity, follicle stimulating hormone and N-terminal telopeptide in the postmenopausal women

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Menopause is characterized by rapid decreases in bone mineral density, aerobic fitness, muscle strength, and balance. In the present study, we investigated the effects of new sports tennis type exercise on aerobic capacity, follicle stimulating hormone (FSH) and N-terminal telopeptide (NTX) in the postmenopausal women. Subjects were consisted of 20 postmenopausal women, who had not menstruated for at least 1 yr and had follicle-stimulating hormone levels >35 mIU/L, estradiol levels<40 pg/mL. The subjects were randomly divided into two groups: control group (n=10), new sports tennis type exercise group (n=10). New sports tennis type exercise was consisted of warm up (10 min), new sports tennis type exercise (40 min), cool down (10 min) 3 days a per week for 12 weeks. The aerobic capacities were increased by 12 weeks new sports tennis type exercise. New sports tennis type exercise significantly increased FSH and NTx levels, indicating biochemical markers of bone formation and resorption. These findings indicate that 12 weeks of new sports tennis type exercise can be effective in prevention of bone loss and enhancement of aerobic capacity in postmenopausal women.

Keywords: New sports tennis type exercise, Aerobic capacity, Follicle stimulating hormone, N-terminal telopeptide, Postmenopausal women

INTRODUCTION

Menopause is often characterized by many changes that may induce a phase of rapid decreases in bone mineral density, aerobic fitness, muscle strength, and balance, especially in sedentary women (Asikaine et al., 2004). Follicle-stimulating hormone (FSH) is a glycoprotein gonadotropin secreted by the anterior pituitary in response to gonadotropin-releasing hormone (GnRH), which is released by the hypothalamus. FSH directly plays an important role in regulation of bone mass directly by stimulating osteoclastic bone resorption (Sun et al., 2006). Devleta et al. (2004) reported that bone mineral density significantly decreased in relation to increased FSH levels in postmenopausal women. Bone remodeling involves bone resorption and bone formation. Bone formation was assessed by serum osteocalcin (OC), serum bone-specific alkaline phosphatase (B-ALP), serum C-propeptide of type I collagen (PICP), and bone resorption by C-telopeptide (CTx) and N-terminal telopeptide (NTX). Of these, NTx is a direct degradation product of the bone resorption process conducted by osteoclasts and elevated levels of NTx indicate increased bone resorption (Takahashi et al., 2002).

Cardio Tennis is new sports tennis type exercise that combines the best features of the sport of tennis with cardiovascular exercise. However, the effects of new sports tennis type exercise on aerobic capacity, FSH, and NTX have not yet been explored. In the present study, we investigated the effects of new sports tennis type exercise on aerobic capacity, FSH and NTX in the postmenopausal women.

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MATERIALS AND METHODS

Subjects

Subjects were consisted of 20 postmenopausal women, who had not menstruated for at least 1 yr and had follicle-stimulating hormone levels > 35 mIU/L, estradiol levels < 40 pg/mL. The subjects were randomly divided into two groups: control group (n = 10), new sports tennis type exercise group (n = 10). The physical characteristics of subjects are shown in Table 1.

Aerobic capacity

In order to estimate VO_2max, ventilation (VE), before and after the training intervention, each performed a graded exercise test on a treadmill using the Bruce's protocol.

Exercise training protocol

New sports tennis type exercise was consisted of warm up (10 min), main exercise (40 min), cool down (10 min) 3 days a per weeks for 12 weeks. New sports tennis type exercise program comprises circuit exercise including side step, cross over step, sprint & back step, running, forehand stroke drill, back-hand stroke drill, forehand and back hand running stroke drill, and approach drill. Training intensity was consisted of 50 to 60% HRmax at 1-6 weeks and 61-70% HRmax at 7-12 weeks using Karvonen's equation.

Blood sampling and analysis

Blood sampling was performed before the exercise, after 6 weeks, and after 12 weeks. All samples were placed in 300 μL aliquots in Eppendorf® tubes, stored at -70°C. FSH was as analyzed by radioimmunoassay (ADVIA Centaur®, Bayer Health care, Tarrytown, NY, USA). NTx was measured by enzyme linked immunoassay (Ostex International Inc., Seattle, WA, USA).

Data analysis

The results were analyzed by two-way repeated measures ANOVA and Duncan's post-hoc test was performed. Statistical significance was set at $P < 0.05$.

Table 1. Physical characteristics of subjects

Groups	Age (yr)	Weight (kg)	Height (cm)	BMI (kg/m^2)
EG (n = 10)	55.13 ± 3.24	62.22 ± 3.76	158.29 ± 3.41	24.92 ± 1.12
CG (n = 10)	54.11 ± 1.78	61.31 ± 2.64	157.34 ± 4.51	24.87 ± 1.53

Values are mean ± SD. EG, exercise group; CG, control group.

Table 2. Change of aerobic capacity

Item	Groups	0 week	6 weeks	12 weeks	2-way ANOVA	F	*P*
VO_2max (mL/kg/min)	EG	25.85 ± 2.62^a	30.46 ± 3.75^b	31.41 ± 5.21^c	Group	29.901	0.000***
	CG	23.77 ± 2.14	24.59 ± 1.04	24.86 ± 1.95	Time	5.331	0.008**
					Group*Time	2.482	0.094
VE (l/min)	EG	47.17 ± 4.52^a	55.98 ± 9.99^b	57.76 ± 5.98^c	Group	19.097	0.000***
	CG	42.53 ± 7.44	44.95 ± 6.81	46.33 ± 9.37	Time	4.464	0.017*
					Group*Time	1.134	0.330

Different letters (a-c) denote statistically significant differences ($P < 0.05$) after Duncan post-hoc. Values are mean ± SD. *$P < 0.05$. **$P < 0.01$. ***$P < 0.001$. EG, exercise group; CG, control group.

Table 3. Change of FSH and NTx

Item	Groups	0 week	6 weeks	12 weeks	2-way ANOVA	F	*P*
FSH (mIU/mL)	EG	80.54 ± 9.83^a	75.32 ± 7.05^a	66.04 ± 16.55^b	Group	5.457	0.023*
	CG	82.50 ± 8.45	76.74 ± 6.76	80.76 ± 7.91	Time	3.431	0.040*
					Group*Time	2.832	0.068
NTx (nM BCE)	EG	17.2 ± 5.43	16.24 ± 4.25	15.30 ± 3.29	Group	7.271	0.009**
	CG	17.0 ± 2.85	20.76 ± 2.33	19.02 ± 4.11	Time	0.846	0.435
					Group*Time	2.153	0.126

Different letters (a-b) denote statistically significant differences ($P < 0.05$) after Duncan post-hoc. Values are mean ± SD. *$P < 0.05$. **$P < 0.01$. EG, exercise group; CG, control group; FSH, follicular stimulating hormone; NTx, N-telopeptide.

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RESULTS

Changes of 12 weeks new sports tennis type exercise on aerobic capacity

The results are presented in Table 2. VO_2max and ventilation were significantly increased after 6 weeks and 12 weeks (P = 0.008, P = 0.017, respectively). The VO_2max and ventilation were higher in the exercise group than those in the control group after 6 weeks and 12 weeks. However, interaction between group and time showed no significant difference.

Changes of 12 weeks new sports tennis type exercise on FSH and NTx

The results are presented in Table 3. FSH was significantly decreased after 12 weeks (P = 0.04). FSH was lower in the exercise group than those in the control group after 12 weeks. However, interaction between group and time showed no significant difference. NTx was lower in the exercise group than those in the control group (P = 0.009). However, interaction between group and time showed no significant difference.

DISCUSSION

Exercise is generally considered providing an osteogenic stimulus to the bones, by increasing serum concentrations of bone formation markers as well as decreasing bone reabsorption markers (Iwamoto et al., 2001). In the present study, we investigated about effects of 12 weeks of new sports tennis type exercise on aerobic capacity, FSH and NTx in the postmenopausal women.

Aerobic exercise training is known to improve aerobic capacity in postmenopausal women (Rahnama et al., 2010). In the present study, 12 weeks of new sports tennis type exercise training, VO_2max and VE levels were increased in new sports tennis type exercise group compared with the control group.

Serum FSH is a marker of bone loss (Sun et al., 2006). Sun et al. (2006) reported that enhanced FSH levels may directly induce bone loss. In the present study, new sports tennis type exercise significantly increased FSH levels, indicating biochemical markers of bone reabsorption.

NTX is established biochemical markers of bone formation and reabsorption, respectively, and may be used as reliable measures of bone metabolism (Looker et al., 2000). Yamazaki et al. (2004) reported that walking exercises decreased urine NTx levels in postmenopausal osteopenic women after the 12 months exercise training. However, Shibata et al. (2003) demonstrated that walking and high-impact exercises did not change NTx levels significantly. In the present study, NTx levels showed a decrease in the NTx levels by 12 weeks of new sports tennis type exercise, but had no significant difference. These findings indicate that 12 weeks of new sports tennis type exercise can be effective in prevention of bone loss and aerobic capacity impairment in postmenopausal women.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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