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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INTRODUCTION

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

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$_2$max, 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, foremost stroke drill, back-hand stroke drill, forehead 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 immunnoassay (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$_2$max (mL/kg/min) | EG | 25.85 ± 2.62* | 30.46 ± 3.75* | 31.41 ± 5.21* | 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* | 55.98 ± 9.99* | 57.76 ± 5.98* | 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* | 75.32 ± 7.05* | 66.04 ± 16.55* | 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 | 0.008** |
| | CG | 17.0 ± 2.85 | 20.76 ± 2.33 | 19.02 ± 4.11 | Time | 0.846 | 0.436 |
| | | | | | 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.
RESULTS

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

The results are presented in Table 2. VO\textsubscript{2}\text{max} and ventilation were significantly increased after 6 weeks and 12 weeks ($P = 0.008, P = 0.017$, respectively). The VO\textsubscript{2}\text{max} 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\textsubscript{2}\text{max} 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.

REFERENCES

Asikainen TM, Kuukkonen-Harjula K, Miilunpalo S. Exercise for health for early postmenopausal women: a systematic review of randomised controlled trials. Sports Med 2004;34:753-778.

Devleta B, Adem B, Senada S. Hypergonadotropic amenorrhea and bone density: new approach to an old problem. J Bone Miner Metab 2004; 22:360-364.

Iwamoto J, Takeda T, Ichimura S. Effects of exercise training and detraining on BMD in post-menopausal women with osteoporosis. J Ortho Sci 2001;6:128-132.

Looker AC, Bauer DC, Chesnut CH 3rd, Gundberg CM, Hochberg MC, Klee G, Kleerekoper M, Watts NB, Bell NH. Clinical use of biochemical markers of bone remodeling: current status and future directions. Osteoporos Int 2000;11:467-480.

Rahnama N, Nouri R, Rahmanninia F, Damirchi A, Emami H. The effects of exercise training on maximum aerobic capacity, resting heart rate, blood pressure and anthropometric variables of postmenopausal women with breast cancer. J Res Med Sci 2010;15:78-83.

Shibata Y, Ohsawa I, Watanabe T, Miura T, Sato Y. Effects of physical training on bone mineral density and bone metabolism. J Physiol Anthropol Appl Human Sci 2003;22:203-208.

Sun L, Peng Y, Sharrow AC, Iqbal J, Zhang Z, Papachristou DJ, Zaidi S, Zhu LL, Yaroslavskiy BB, Zhou H, Zallone A, Sairam MR, Kumar TR, Bo W, Braun J, Cardoso-Landa L, Schaffer MB, Moonga BS, Blair HC, Zaidi M. FSH directly regulates bone mass. Cell 2006;125:247-260.

Takahashi M, Kavana K, Nagono A. Biological variability of biochemical markers of bone turnover in healthy women. Endocr Res 2002;28:257-264.

Yamazaki S, Ichimura S, Iwamoto J, Takeda T, Toyama Y. Effect of walking exercise on bone metabolism in postmenopausal women with osteopenia/osteoporosis. J Bone Miner Metab 2004;22:500-508.