Metabolic Effect of Exercise in Ovariectomized Mature Multiparous Rats

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We studied the effect of exercise on ovariectomized mature multiparous rats. Old retired breeder Sprague-Dawley rats were ovariectomized and divided into a sedentary and a treadmill-trained (20 weeks) groups. Exercise training decreased body weight gain, fat weight around the uterus and plasma triglyceride content significantly compared with the sedentary group, but food intake was unaffected. Extensor digitorum longus and soleus muscle weights and their glycogen content showed a significant increase in the training group. These results suggested that exercise training in ovariectomized multiparous rats is associated with decreased body weight gain and enhanced glycogen storage.

Key words —— exercise, multiparous rat, ovariectomy, glycogen, triglyceride

INTRODUCTION

It is well known that sex hormone deficiency affects body composition and various functions in postmenopausal women. Therapies to prevent these changes include hormone-replacement therapy, diet, and physical exercise.[1)] Ovariectomized (OVX) rats have been used as a human menopause clinical model and to test the function of hormones or various drugs. The effects of exercise on OVX rats have also been studied and found to have beneficial effects on increase of body weight and decrease of bone mass in OVX rats.[2–5)] To determine the above effects of ovarian hormone deprivation, most animal studies have investigated ovariectomized virgin rats. The objective of this pilot study is to examine the effect of repeated pregnancies on the training efficacy.

In this report, we examine the effect of exercise training on body composition in the ovariectomized old retired breeder rats.

MATERIALS AND METHODS

Animals —— The animal procedures were reviewed and approved by the Animal Research Committee of Gifu Women's University and the Japanese Government Animal Protection and Management Law. Female old retired breeder SD rats weighing 255 ± 10 g were obtained from Japan SLC Inc. (Shizuoka, Japan). The rats were housed in standard cages and fed with standard laboratory chow and tap water ad libitum. They were then bilaterally ovariectomized under anesthesia with thiopental sodium after being maintained in our facility for a week.

Groups and Training Program —— One month after surgery, the rats were divided into trained (OVXTR) and sedentary groups. Exercise training consisted of continuous running on a motor-driven rodent treadmill three times a week for 20 weeks. Rats were made to run from 10 min/day at 13 m/min, 6° slope for a week, up to 60 min/day for the last 19 weeks. All rats were monitored for body weight and food intake.

Analytical Methods —— Peripheral blood was collected with heparin sodium (Shimizu Pharmaceutical Co., Japan) and centrifuged.

Plasma triglyceride concentration was determined by a commercially available kit (Wako Pure Chemical, Tokyo, Japan). For determination of skeletal muscle glycogen content, the rats were sacrificed by decapitation 48 hr after training cessation.

The extensor digitorum longus (EDL) and soleus (SOL) muscle were excised and weighed. Muscles were dissolved in 30% potassium hydroxide (KOH), and glycogen was precipitated by ethanol according to the standard method.[6)] Glycogen samples were digested by amyloglucosidase to release glucose, and glucose content was determined by a commercially available kit (Wako Pure Chemical).

Statistics —— Results are expressed as the mean ± S.E. Student's *t*-test was used for statistical comparison.

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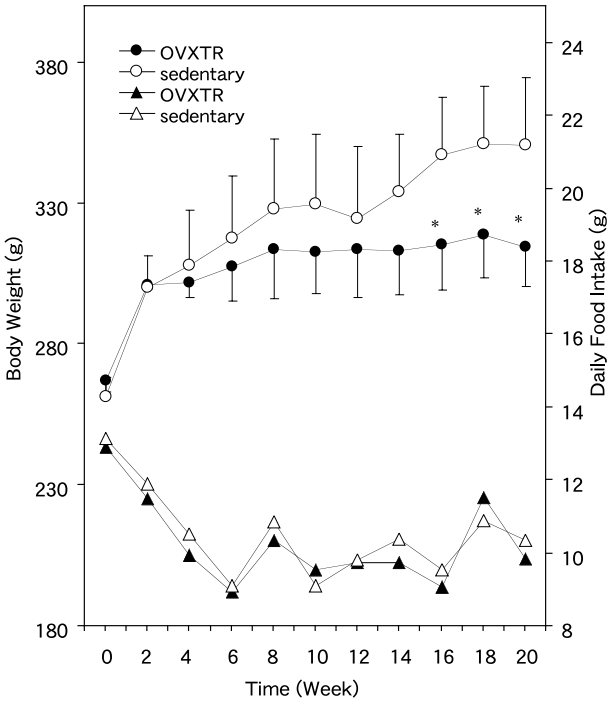

Fig. 1. Effect of Exercise on Body Weight (Circles) and Food Intake (Triangles) in Ovariectomized Multiparous Rats

Results are presented as the mean ± S.E. of four rats: *$p < 0.05$.

RESULTS AND DISCUSSION

In the present study, the training group showed a significant reduction in body weight gain compared with that in the sedentary group (Fig. 1). There were no significant reduction in daily food intake (Fig. 1). In other studies, body weight of OVX rats were significantly greater than those of sham-operated rats, but these was no increase in exercise training.[3,4] These results suggested that the training condition have been shown to suppress OVX-induced weight gain in ovariectomized multiparous rats. In this experiment, EDL and soleus muscle weight in the training group increased significantly compared with the sedentary group (Fig. 2). This exercise training condition seems to generate significant aerobic and anaerobic effect in OVX mature multiparous rats.

The plasma triglyceride level and fat weight around the uterus were significantly decreased by training (Table 1). The increase in mesenteric and subcutaneous fat weights in OVX rats were abolished by treadmill-training (8 weeks).[2] These results mean that training has a beneficial effect on changes in body composition in OVX multiparous rats.

EDL and SOL muscle glycogen content in the training group increased significantly compared with

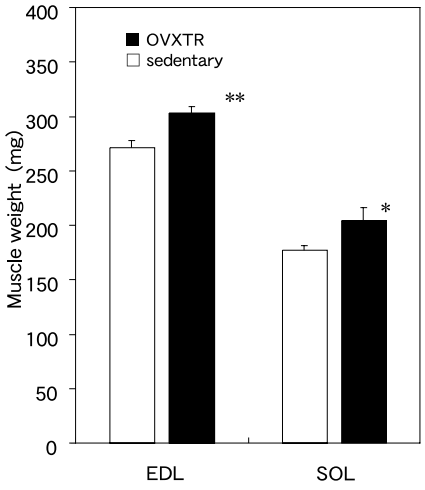

Fig. 2. Effect of Exercise on Muscle Weight in Ovariectomized Multiparous Rats

Results are presented as the mean ± S.E. of four rats: **$p < 0.01$; *$p < 0.05$.

Table 1. Effect of Exercise on Adipose Tissue Weight around Uterus and Plasma Triglyceride Concentration in Ovariectomized Multiparous Rats

Group	Adipose tissue	Triglyceride
Sedentary	5.90 ± 1.58	64.3 ± 12.3
Exercise	2.98 ± 0.52*	38.0 ± 13.2*

Adipose tissue weight is expressed as g, triglyceride as mg/dl. Results are presented as the mean ± S.E. of four rats: *$p < 0.05$.

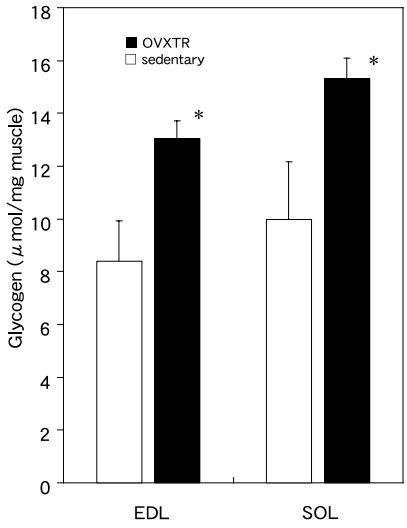

Fig. 3. Effect of Exercise on Glycogen Content in Ovariectomized Multiparous Rats

Glycogen content is expressed as μmoles glycosyl units per mg wet muscle weight. Results are presented as the mean ± S.E. of four rats: *$p < 0.05$.

the sedentary group (Fig. 3). Exercise training significantly increased muscle glycogen storage and GLUT4 protein levels.[7)]

In conclusion, the beneficial metabolic effects of training were observed in multiparous OVX rats.

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