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LIPOPROTEIN LIPASE ENZYMEHISTOCHEMICAL ACTIVITY IN SUBCUTANEOUS ADIPOSE TISSUE AND SKELETAL MUSCLE OF THE RAT AFTER SUBMAXIMAL EXERCISE TRAINING

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ABSTRACT. The aim of the present work was to study the effect of submaximal exercise training on the lipoprotein lipase (LPL) activity in subcutaneous adipose tissue and skeletal muscles in the rat. Male rats were randomly distributed into 2 groups (n=6): sedentary and trained. The exercised rats trained on treadmill for 8 weeks. Twenty-four hours after the last bout of exercise the animals were decapitated and on fresh frozen fragments of subcutaneous adipose tissue and m. soleus of each animal an enzymehistochemical reaction for LPL was carried out. The results showed that there were no differences in the enzymehistochemical reaction for LPL in the adipose cells of the trained rats in comparison with the control rats. In m. soleus of the trained rats LPL enzymehistochemical activity was strong. In the same muscle of the sedentary animals LPL activity was very slightly or not at all expressed. Our findings demonstrate that submaximal exercise has an effect on muscle LPL activity while adipose tissue LPL activity is not responsive to it.

KEY WORDS: lipoptotein lipase- adipose tissue- skeletal muscle

INTRODUCTION

Lipoprotein lipase (LPL) is a central enzyme in lipid metabolism, and is responsible for catabolism of the triglyceride core of circulating chylomicrons and very low-density lipoproteins into nonesterified fatty acids (NEFA) and glycerol [1]. LPL is predominantly expressed in adipose tissue and muscle, and is important for the uptake of triglyceride-rich lipoproteins from plasma [2, 3]. In this way LPL is important for the provision of energy substrate for the muscles. LPL and hormone sensitive lipase (HSL) are rate limiting steps for the turnover of fatty acids in adipose tissue, because they hydrolyze extracellular triglycerides in lipoproteins and intracellular triglycerides in adipocytes [4]. The regulation of LPL is complex. Under some physiologic conditions (feeding, exercise, etc.), adipose tissue and muscle LPL are regulated inversely [5, 6]. In rats the increase of adipose LPL with feeding is accompanied by a decrease in heart LPL [5]. There is an increase in LPL activity in heart muscle of acutely exercised animals [7]. Exercise training increases LPL activity in plasma and parenchymal cells in skeletal muscles [3, 9, 10], while in adipose tissue and heart LPL is not responsive to long-term exercise training [3]. However, the question of the effect of training on adipose tissue and muscle LPL activity is not yet elucidated.

Aim: The present study was undertaken to determine the effect of submaximal exercise training on the activity of LPL in rat subcutaneous adipose tissue and skeletal muscles.

MATERIAL AND METHODS

The Ethic Committee at the Medical University of Plovdiv approved the experiment. Male Wistar rats (initial body weight 200-220g) were placed in individual cages and received standard chow and water *ad libitum*. ***Training Programme***: The rats were randomly distributed into 2 groups (n=6) - sedentary (S) and trained (T). The exercised rats trained on motor-driven treadmill with submaximal loading (about 70-75 % VO2 max) 5 days per week for 8 weeks. During the first 2 weeks the duration of the daily training session increased every second day. At the end of 2^{nd} week the rats run 40 min per day and this loading was maintained to the end of the experiment. Twenty-four hours after the last bout of exercise the animals were anesthesized with tiopenthal and were killed by decapitation. Fragments were resected from the subcutaneous adipose tissue of the femoral region and from m. soleus of each animal. They were immediately frozen at –20° C in cryostat. On fresh cryostat sections (6 μm thick) enzymehistochemical reaction for LPL by the Twin method by Gomori (1952) was performed. The controls for the enzymehistochemical reaction were carried out without Tween.

RESULTS

Training for 8 weeks resulted in no differences in the weight of the trained and sedentary rats (p>0,05).

Following submaximal treadmill training, the results of the enzymehistochemical reaction showed that in the adipocytes of the trained rats there were no significant differences in the activity of LPL in comparison with the control rats (Fig.1, 2).

At the same time treadmill training had a significant effect on LPL activity in slow-twitch skeletal muscles. In m. soleus of the trained rats the enzymehistochemical reaction for LPL was strong. In the same muscle of the sedentary animals LPL activity was very slightly or not at all expressed. (Fig.3, 4)

DISCUSSION

Our results demonstrate that endurance treadmill training exerts some effects on the activity of LPL. The regulation of adipose tissue and muscle LPL under some physiologic conditions including exercise is complex [5, 6]. LPL activity was observed to be increased in heart muscle of acutely exercised animals [7]. Exercise training increases LPL activity in plasma and parenchymal cells in skeletal muscles [3, 9, 10]. Voluntary exercise training induces a selective increase in LPL activity in a muscle containing a high percentage of fast-twitch red fibers, a response absent in a muscle containing a predominance of slow-twitch red fibers [8]. In a study in which LPL activity was measured biochemically in tissue homogenates, it was proved that training on treadmill led to an increase in LPL activity in m. soleus and EDL in rats, but had no effect on adipocytes and heart LPL [3]. At the same time feeding induced a large increase in adipose tissue LPL activity and yielded a significant decrease of LPL in EDL. The authors concluded that adipose tissue and heart were highly regulated by feeding and not responsive to long-term exercise training [3].

Our results suggest that in treadmill trained rats enzymehistochemical expression of LPL activity in subcutaneous adipose tissue demonstrates no change as compared to the sedentary control rats. These data to a certain extent confront with the results reported by athor authors [11] demonstrating that one bout of exercise increases almost twofolds LPL activity in the soleus muscle and at the same time reduces it 43% in adipose tissue. We think that the differences in the results depend on the different type of experiment.

Endurance exercise training induces a number of adaptations in skeletal muscles. The most important of these changes is the increase of muscle oxidative capacity [12]. As a cosequence there is increased utilization of fats with a proportional decrease in carbohydrate utilization as energy substrate for muscle contraction during submaximal exercise [13]. In our experiment submaximal training leads to an increase in the positivation of LPL in slow-twich m. soleus. These results suggest that as a consequence triglyceride metabolism in the muscle is altered. Our findings confirm that during submaximal exercise LPL is the enzyme that provides the skeletal muscles with triglycerides from plasma [3].

CONCLUSION

Our findings show that adipose tissue LPL activity is not responsive to treadmill submaximal training. On the other hand submaximal exercise influences LPL activity in m. soleus.

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FIGURE

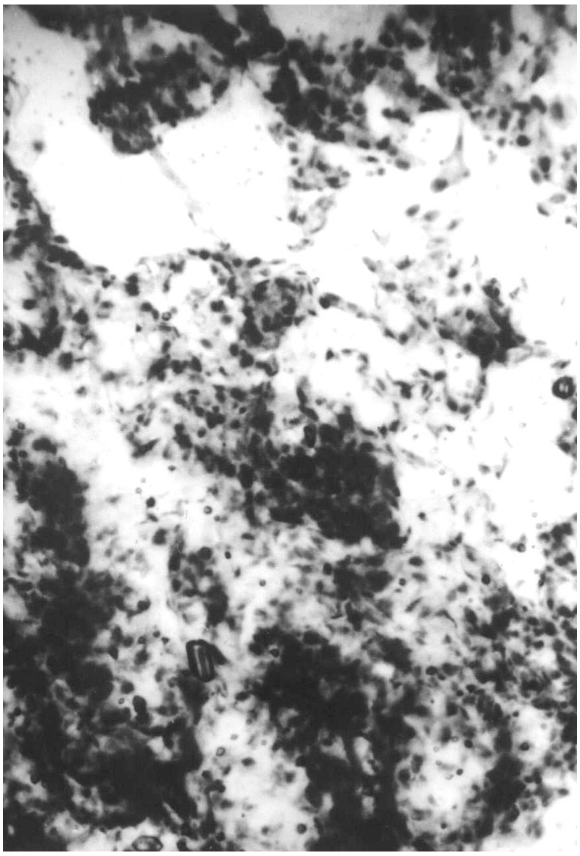

Fig.1. *LPL activity in adipose tissue of a trained rat. X200.*

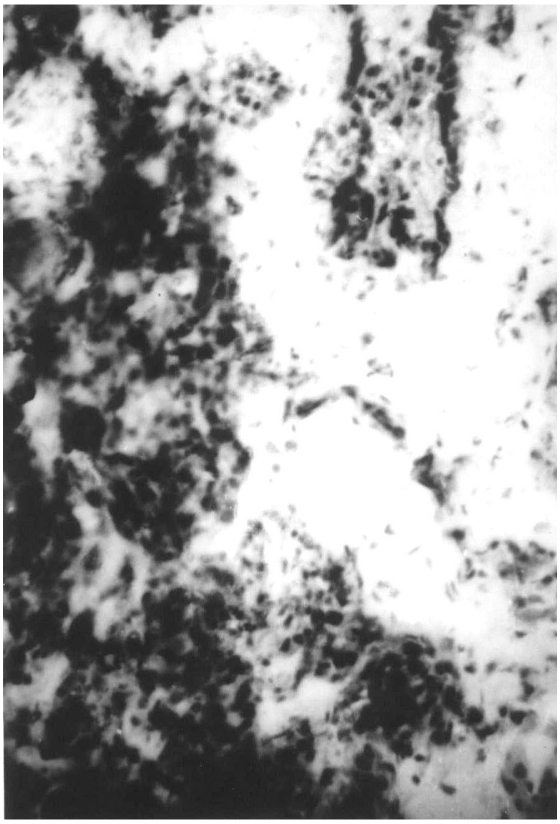

Fig.2. *LPL activity in adipose tissue of a sedentary rat. X200.*

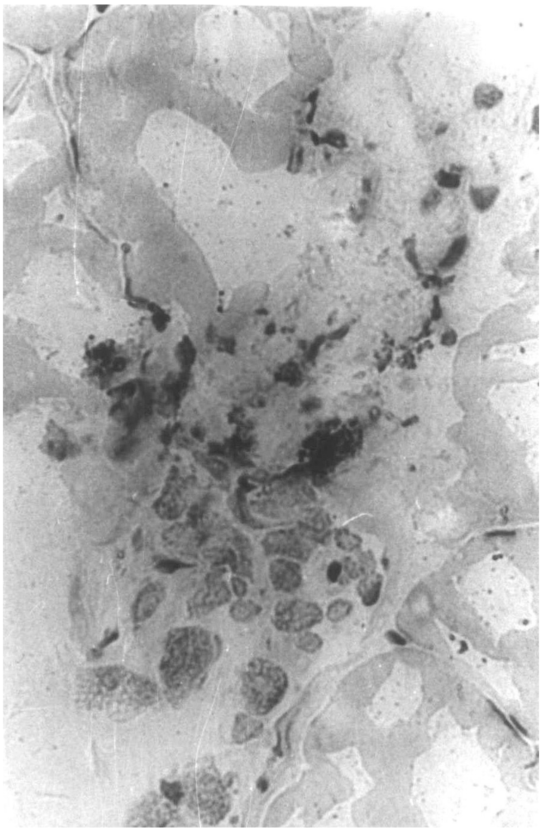

Fig.3. *LPL activity in m. soleus of a trained rat. X200.*

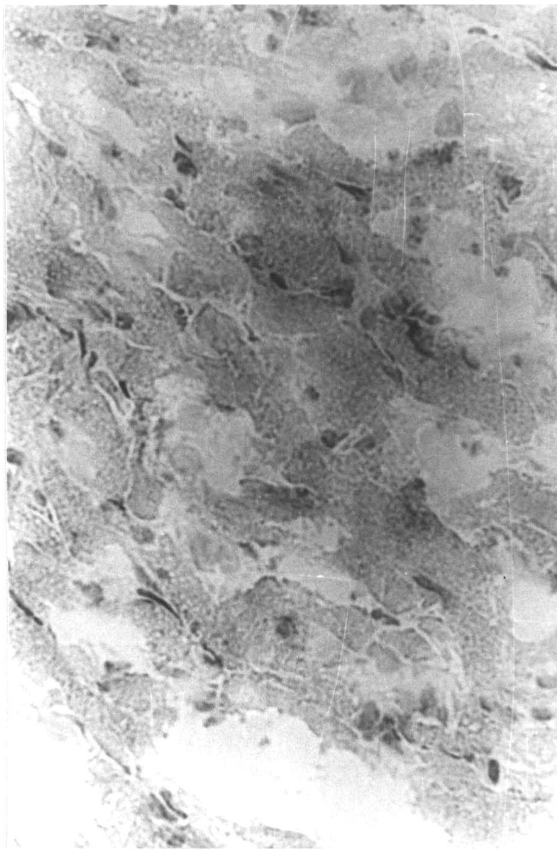

Fig.4. *LPL activity in m. soleus of a sedentary rat. X200.*