Aerobic Exercise Training Attenuates Cigarette Smoking Induced Harmful Effects on Skeletal Muscle in Animal Model

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Cigarette smoking (CS) is one major risk factor that causes Chronic Obstructive Pulmonary Disease (COPD). Emerging evidence suggests that CS induces extra-pulmonary manifestation as reflected by the alteration of skeletal muscle properties, further reducing exercise tolerance. Previous studies reported that aerobic exercise improved the modifying myofiber metabolism and evoking redox signaling which is essential for muscle remodelling. Thus, this study aims to examine if aerobic exercise training would alter the CS-associated detrimental effect on skeletal muscle dysfunction and explore the associated mechanism involved. Forty-six Sprague Dawley rats (6-week-old) were randomly allocated into CS and sham-air (SA) exposure groups for 8 weeks. Further, SA and CS groups were divided into non-training group (SAN, CSN) and 3 levels of exercise training at high intensity (SAH and CSH), moderate intensity (SAM and CSM) and low intensity (SAL and CSL). Exercise tolerance was assessed by the maximal running speed achieved during treadmill test. Muscle properties were assessed by the fiber type proportion of soleus. Oxidative stress related markers, of soleus, including reactive oxygen species (ROS), activity of catalase and superoxide dismutase antioxidant enzyme (SOD) were examined by biological analysis. Exercise training groups showed higher maximal running speed than non-training group in both SA and CS groups. In terms of muscle properties, two-way ANOVA showed that CS groups demonstrated significantly lower proportion of type I (SA: 87.7% vs CS:81.4%)and higher proportions of type IIa (SA: 10.3% vs CS:15.9%) fiber when compared to SA groups. Compared to non-training group, exercise groups regardless of the levels of intensity and exposure nature, demonstrated higher levels of type I fiber. Among all, moderate intensity showed the highest proportion of type I fiber. Two-way ANOVA revealed that there was a significant interaction between smoking exposure and exercise intensity on the level of ROS in soleus. The ROS level in CSN groups were higher than that in SAN groups. For SA groups, a trend of increased level of ROS was found as the exercise intensity increased. In contrast, a non-uniform “U” shape was noted in CS groups suggesting a plausible suppression of ROS level up training at low and moderate intensity training, but not in high intensity, Moreover, SOD enzyme showed a significantly higher level in the exercise group but no significant difference in catalase. Exercise attenuates the CS-induced muscle fiber type alteration. The potential protective changes may be associated with the activation of antioxidant and suppression of oxidative damage.

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