Correlation between exercise performance and muscle electrical activity in Exercise-induced Fatigue Rats

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Objective Assess the muscle contraction ability of rats before and after exercise fatigue quantitatively, and analyze the correlation between exercise performance and muscle electrical activity. This study intends to provide a theoretical principle for exercise fatigue.

Methods 7 healthy adult male SD rats (300~350g) were used and trained for adaptive treadmill by running on the treadmill for 1 week and holding on a vertical rectangular railing (20×10cm, 10 iron bars) until it's mastered. After this training, we used rat grasping force tester(BioSEB GS3) to measure the maximum grasping force(MGF) of rat's limbs, each rat was carried out 3 times, bout interval is 2 minutes. In addition, the grasping bar time(GBT) was recorded 3 times , bout interval is 30 minutes. We let rats to grasp and hold on a vertical rectangular railing(20×10cm， 10 iron bars), evaluation of rat muscular endurance by grasping bar time(GBT), each rat was carried out 3 times, bout interval is 30 minutes; During the MGF and GBT test, motor unit recruitment and discharge frequency was predicted by measuring the EMG of extensor muscles of the right hindlimb and flexor elbow muscles of the right forelimb by wireless non-invasive miniature surface EMG tester (Italy, BTS FREEEMG), the max Root Mean Square (maxRMS) and Median Frequency (MF) parameter was used to evaluate motor unit recruitment and discharge frequency, respectively.

After these, the rats were allowed to have a one-day rest, and then had a load motion program on the treadmill (three levels' load: the first stage movement speed 8.2 m/min, exercise time 15 min; second stage speed 15 m/min, exercise time 15 min; third stage speed at 20 m/min, exercise to fatigue) to build the rats EF model by monitoring the acceleration of the rat's sprint with a miniature wireless acceleration sensor (18g). 30 continuous sprint acceleration at the end of running was less than half of initial acceleration and the running posture of the rats changed to prostrate, and remained at the end of the runway for a long time. Later, quantitative correlational data analyses such as mean, Pearson correlation, analysis of one-way ANOVA and paired sample t test were performed in this study.

Results (1) The rats' sprint acceleration of treadmill exercise at the end stage (the final 1/5 of the total time) decreased by 56.9% (P < 0.01) when compared with the early stage (the begining 1/5 of the total time). (2) The MGF and GBT of EF decreased by 68.1% (P < 0.01) and 90.38% (P < 0.01), respectively when compared with the beginning EF; in addition, the EMG maxRMS and MF of hindlimb and forelimb of EF rats had significantly reduced (P < 0.01), and the rats' MGF/GBT was positively correlated with EMG maxRMS/MF significantly (MGF: forelimb r_{maxRMS} = 0.901, P < 0.01， r_{MF} = 0.761, P < 0.01; hindlimb r_{maxRMS} = 0.913, P < 0.01， r_{MF} = 0.783, P < 0.01; GBT: forelimb r_{maxRMS} = 0.922, P < 0.01， r_{MF} = 0.806, P < 0.01; hindlimb r_{maxRMS} = 0.908, P < 0.01， r_{MF} = 0.896, P < 0.01).

Conclusions Exercise fatigue reduced the muscle strength, muscular endurance and muscle power of rates significantly, which may be related to the decreased recruitment, rhythm synchronization and discharge frequency of muscle motor units of forelimb flexor and hindlimb extensor.