EFFECTS OF CARDIO-RESPIRATORY COUPLING INDUCED BY DIFFERENT PATTERNS OF EXERCISE IN HUMANS

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Purpose : Previous studies have demonstrated a predominance of whole number ratios in heart rate (HR) and breathing frequency at rest and the HR per breathing frequency (HR/f) ratio appears to be 3:1 and 4:1 at rest. There have been few reports concerned with HR/f ratio during exercise. We are most interested in the coupling between exercise-induced cardiac response and the respiratory system, during different repeated exercises, known as respiratory sinus arrhythmia. However, the physiological role for change of HR/f ratio during exercise is unknown in humans. The aim of this study is to test the effects of cardio-respiratory coupling (HR/f) ratio induced by different patterns of exercise in humans.

Methods : 4 healthy subjects (39.5 years) were used in this study and different patterns of exercise were measured using a bicycle ergometer. The patterns of exercise were step exercise for 4 minutes (SL), ramp exercise for 4 minutes (RL), and interval exercise for 1 minute 3 times (IL). All subjects performed the exercise for 4 minutes at 90 % anaerobic threshold. Each exercise consisted of 5 sets. Gas and cardio-vascular parameters were measured simultaneously during the pedaling exercise at SL, RL and IL. EMG of vastus lateralis muscle was also measured during each exercise.

Results : The average HR/f ratio was 5.2 ± 1.79 at rest. HR/f ratio response to repeated exercise changed with different exercise types. In RL, HR/f ratio response did not change with rate of load. The average HR/f ratio was 5.1 ± 1.25 from the 1st to the 5th repeated exercise and was the same at rest. HR/f ratio response in SL increased more than at rest at the onset of the 1st exercise but in the 5th exercise HR/f ratio response was not high with a constant load for 4 minutes. Modulation of HR/f ratio in SL and IL with the passage of time was greater than in RL. Two patterns in the relationship between HR/f ratio and EMG (rms-EMG) were observed. One of the patterns showed a positive correlation between HR/f ratio and rms-EMG, however the other pattern showed no correlation.

Discussion : To maintain steady levels of aerobic exercise the exercises were performed below AT level. Therefore, the recruitment of motor units increased with rising exercise intensity. In the case of the subjects where a correlation between HR/f ratio and rms-EMG in RL exercise was observed, the recruitment of motor units and cardio-respiratory coupling were entrained. Thus, these results might suggest an influence of central neural drive in which the motor command was sent to muscle directly. This study shows that HR/f ratios in resting subjects were similar to those observed during exercise. These results suggest that HR/f ratio during different exercise is influenced by central command of cardio-respiratory coupling induced by the neural drive of motor units and the peripheral reflex.

Keywords: Physiology