Recording of neuromuscular activities of rats in a real microgravity environment using telemetry system

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Summary

Responses of electromyogram (EMG) of soleus, lateral portion of gastrocnemius (LG), and tibialis anterior (TA) muscles to altered gravity levels, created by the parabolic flight of a jet airplane, were investigated in adult rats. Soleus muscle showed the tonic activity in 1~2-G environment. But the activity was silent during the 20-sec microgravity. EMG of LG muscle also responded similarly to the exposure to microgravity, but the changes were minor. However, EMG level of TA was even increased in response to the exposure to microgravity. These data indicated that soleus muscle was more susceptible to the altered gravity level.

Introduction

Fiber atrophy associated with a shift toward fast-twitch type is induced in slow-twitch antigravity muscle following exposure to microgravity environment. The adaptations to microgravity might be related to the changes in the neuro-motor system, although the precise mechanisms are still unknown. The present study was carried out to investigate the responses of electromyogram (EMG) in rat hindlimb muscles to changes of gravity levels by the parabolic flight.

Methods

EMG recording. Bipolar electrodes were implanted in soleus, lateral portion of gastrocnemius (LG), and tibialis anterior (TA) muscles of adult rats. The signals were amplified and sent a receiver using a telemetry placed on the head of the rat. The band range of ~200MHz was used to send the signals.

Parabolic flight. Changes in the environmental gravity levels were created by the parabolic flight performed by a jet airplane (Mitsubishi MU-300, Diamond Air Service, Nagoya, Japan). The period of each experiment was 1 hr per day. Within each experimental period, 13–15 parabolic flights were repeated. Various levels of gravity between 0-G and 2-G were created during the ascending and descending periods. Microgravity environment was obtained for approximately 20 sec in each parabolic flight.

Results and Discussion

The EMG activity in antigravity soleus muscle gradually increased, when the gravity was elevated from 1-G to 1.5-G (+23%) and 2-G (+67%) during the ascending phase of parabolic flight. The activity decreased ~72% from the 1-G level immediately, when the rat was exposed to microgravity. The EMG level was maintained low during the 20-sec microgravity, but it was restored immediately, once the gravity level was increased to 1.5-G and then 1-G during the descending and recovery phase. The EMG level of LG also increased gradually, when the gravity level was elevated. The EMG level then decreased, when the rat was exposed to microgravity. However, the activity level during the 20-sec microgravity was identical to that obtained at 1-G. The EMG level of TA even increased insignificantly in response to exposure to microgravity. Further, the ankle joint was maintained at plantarflexed position under gravity, but the joint angle was extended to ~160° in microgravity environment. Therefore, it was indicated that the muscle-specific response to the altered gravity level was caused by the change in the posture of rat.