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UTILIZING THREE-DIMENSIONAL MOTION ANALYSIS AND FOOT PRINT DATA TO INVESTIGATE WALKING MOTION OF RATS EXPOSED TO SIMULATED MICROGRAVITY

Abstract

Microgravity environment is well known that adversely affect to physiological systems, especially to musculo-skeletal aspect. However, little studies have been investigated alteration to functional properties of motion such as walking. We have examined adverse effects on rats' walking, evoked by simulated microgravity using hind limb unloading. We revealed that alteration in their walking might persist for a certain period of time after returning to the normal gravity situation as well as potential counter effects of intermittent centrifugation. Through those attempts, we utilized 3-dimensional motion analysis. This approach is specialized in joint angles and joint excursions. Motion analysis could be improved if we incorporated foot print analysis which enables us to investigate length and overlapping of steps etc. The purpose of this study was to investigate gait motion properties of rats affected by microgravity and intermittent centrifugation as a countermeasure using multiple-aspect approach by integration of foot print analysis into 3 dimensional motion analysis. Eighteen male Wistar rats were distributed into 3 groups (Control; Unload; 1.5G, 6 animals for each group). For animals in Unload (UL) and 1.5G (1.5G) group, their hind limbs were unloaded by their tail for 2 weeks (unloading period). Further, 1.5G group was subjected to intermittent hypergravity using centrifugation for 80 minutes a day during the unloading period. Following the unloading period, animals were reloaded onto the ground and kept freely in cages for additional 2 weeks (recovery period). Control (Ctrl) groups were kept freely for entire 4 weeks. Their walking on an animal treadmill was video recorded in every 2 weeks (0wk, at the beginning of the experiment; 2wk, the final day of the unloading period; 4wk, the final day of the recovery period). Their walking on a plexiglass were also recorded for foot print analysis. Out of the 3-D data, we evaluated joint

angle of knee and ankle during midstance, also range of hind limb oscillation. Out of foot print data, we evaluated step length and overlapping of fore/hind limb steps. While UL group exhibited more extended knee and ankle on midstance and narrower oscillation even at 4wk (2 weeks after unloading period), 1.5G group showed attenuated alteration at 4wk. Similarly, step length was shorter and overlapping was smaller in UL group that were less pronounced in 1.5G group. Our results might suggest that incorporation of foot print analysis allow us to understand the walking alteration of rats exposed to microgravity further in detail.