The Role of Adaptation in Body Load-Regulating Mechanisms During Locomotion

Body loading is a fundamental parameter that modulates motor output during locomotion, and is especially important for controlling the generation of stepping patterns, dynamic balance, and termination of locomotion. Load receptors that regulate and control posture and stance in locomotion include the Golgi tendon organs and muscle spindles at the hip, knee, and ankle joints, and the Ruffini endings and the Pacinian corpuscles in the soles of the feet. Increased body weight support (BWS) during locomotion results in an immediate reorganization of locomotor control, such as a reduction in stance and double support duration and decreased hip, ankle, and knee angles during the gait cycle. Previous studies on the effect during exposure to increased BWS while walking showed a reduction in lower limb joint angles and gait cycle timing that represents a reorganization of locomotor control. Until now, no studies have investigated how locomotor control responds after a period of exposure to adaptive modification in the body load sensing system. The goal of this research was to determine the adaptive properties of body load-regulating mechanisms in locomotor control during locomotion. We hypothesized that body load-regulating mechanisms contribute to locomotor control, and adaptive changes in these load-regulating mechanisms require reorganization to maintain forward locomotion. Head-torso coordination, lower limb movement patterns, and gait cycle timing were evaluated before and after a 30-minute adaptation session during which subjects walked on a treadmill at 5.4 km/hr with 40% body weight support (BWS). Before and after the adaptation period, head-torso and lower limb 3D kinematic data were obtained while performing a goal directed task during locomotion with 0% BWS using a video-based motion analysis system, and gait cycle timing parameters were collected by foot switches positioned under the heel and toe of the subjects' shoes. Subjects showed adaptive modification in the body load-regulating mechanisms that included increased head movement amplitude, increased knee and ankle flexion, and increased stance, stride, and double support time, with no change in the performance of the task with respect to that measured before exposure to BWS. These changes in locomotor control are opposite to that reported during 40% BWS exposure and indicative of an after-effect after removal of the adaptive stimulus. Therefore, it is evident that just 30 minutes of 40% BWS during locomotion was sufficient to induce adaptive modifications in the body load sensing systems that contribute to reorganization of sensory contributions to stable locomotor control.