Locomotive Biomechanics Wearing a Simulated Portable Life Support System During Varying Cognitive and Treadmill Grade Conditions

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Background: The Portable Life Support System (PLSS) worn by astronauts during Extravehicular Activity (EVA) is contained within a backpack. Due to the inherent mass of the PLSS, astronaut center of mass (COM) is altered during ambulation. Recent studies from our laboratory suggest shifts in the COM of the PLSS have minimal effects on exercising metabolism, although differences were observed in trunk angles during ambulation. During EVA, astronauts continuously perform cognitive tasks (CG). Due to the distractive nature of these tasks, safety may be compromised by altered biomechanics. **Purpose:** To quantify lower extremity kinematics while walking with a simulated PLSS at variable inclines with and without a cognitive task. **Methods:** Nine subjects underwent treadmill gait analysis walking at 4.0 mph with a flat grade and a 6% decline wearing a 14.5 Kg. PLSS simulator. Within each treadmill grade condition, 30s of 3D motion capture data were collected as subjects walked while looking at a blank computer screen (CON), then while performing a CG. The CG consisted of identifying odd or even numbers and consonant or vowel letters presented for 0.1s on the computer screen. Kinematic data were obtained at 120 Hz using a motion capture system with a Helen Hayes marker set (Motion Analysis Software). Angle kinematic computations were completed using MatLab. Relevant measurements were compared within / between grade and cognitive conditions using a two-way factorial repeated measures analysis of variance test. **Results:** No significant differences were observed in scores on cognitive tests during the two grade conditions. Maximal left ankle plantarflexion was significantly greater in CG compared to CON; no other differences were observed between the CG and CON. There was a 2.5^{o} difference in right knee flexion angle during the stance phase between the flat and decline positions ($p < 0.001$). During the swing phase, grade affected knee flexion by 1.9^{o} ($p < 0.002$). Change in grade also resulted in differences in right and left hip extension in stance phase by 2.8^{o} ($p<0.009$) and 4.3^{o} ($p<0.022$) respectively. **Conclusions:** The cognitive task administered in this investigation is not adversely affected by ambulation at 4.0 mph regardless of treadmill grade. Furthermore, there were minimal effects on walking kinematics during the cognitive task. Subtle biomechanical differences were observed during the two grade conditions within both cognitive conditions. More research utilizing faster treadmill speeds and varying levels of CG may be necessary to detect possible alterations in biomechanics resulting from cognitive tasks.