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GAIT ANALYSIS FOR MARTIAN EXPLORATION

Abstract

During manned exploration of planetary bodies, humans will be exposed to novel gravity environments. Extravehicular activity (EVA) will be critical for these missions to achieve tasks such as habitat construction and geologic investigations. Additionally, gas pressurized space suits needed for EVA impose constraints on movement. We quantify how gravity and the space suit affects locomotion by comparing lower body joint angles during walking in Earth and Martian gravity environments both with and without an exoskeleton that simulates knee joint torques imposed by wearing a spacesuit. **Methodology** Two subjects walked in both Earth and simulated Martian gravity levels, both with and without an exoskeleton to impose additional mechanical torque on the knee joint. Simulated Martian gravity was achieved using a suspension device that partially offloaded the subjects. Treadmill velocities were standardized between subjects and gravity levels using the Froude number. Subjects also walked at their specific earth walking velocity in Martian gravity for constant speed comparison. Joint angle measurements were taken using inertial measurement units (IMU) attached to the neutral axis of the right side of the body. **Results** For both subjects, the range of motion of the knee at earth gravity level was significantly less in the suited case than in the unsuited case. All joint angle ranges, except for the knee angle range at constant speed, were significantly smaller in Martian gravity compared to earth gravity for both the suited and unsuited cases. At Martian gravity, the differences in range of motion for the knee and hip between the two suited conditions at constant Froude number were not always significant, and the effects were generally smaller than the gravitational effects. **Discussion** In general, the range of motion for the knee and hip joints decreased as the simulated gravity level decreased from Earth gravity to simulated Martian gravity for all loading conditions and speed levels. We believe that, as either an effect of the reduced gravity or an artifact of the suspension system, the bodies of the subjects were more vertically extended. Reduced gravitational loading results in a reduced bend in the stance leg, which would lead to a reduction in the necessary bend in the knee of the swing leg to complete the stride. These observed joint range of motion reductions, coupled with a constant, or even slightly increasing gait period in simulated reduced gravity, suggest an effective lengthening of the leg during the walking stride.