Influence of body weight support on wearable devices reproducing normal gait

M. Gomez*, C. Lopez de Subijana, E. Navarro

Technical University of Madrid, Madrid, Spain

Research question: The aim of the present study was to describe the influence of BWS in a fixed gait pattern reproduced by an exoskeleton.

Introduction: The body weight suspension (BWS) with treadmill training has been traditionally reported as a way to facilitate functional gait pattern and to recover musculoskeletal injuries. Nowadays some other wearable electronic devices appear as an alternative to treadmill training, eliminating the effects of walking on a treadmill.

Materials and methods: The present study was carried out with the HYBRID system, which joins together an exoskeleton robot with hip, knee and ankle control and a robotic walker which provides BWS.

An optoelectronic system captured trials with six cameras (120 Hz). Twenty-eight markers were attached to anatomical landmarks following an adapted model from Plug in Gait.

Ten subjects were measured with the wearable exoskeleton reproducing gait at a fixed speed (0.25 m/s) and the smart robotic walker under three conditions: 30%, 50% and 70% BWS.

Results: The non-parametrical Friedman test showed significant differences between the 30%, 50% and 70%BWS ($p < 0.05$). The stance time and the double-limb support time were decreased in 70% compared with 30%BWS. Step width and center of gravity (CG) movement in frontal plane were smaller in 30% than in 50% and 70%BWS.

Knee and ankle maximum and minimum moments occurred after in 30% than in 70%BWS during the gait cycle, and showed higher flexion at heel strike in 30% than in 70%BWS. The ankle also presented higher maximum and minimum values in 30% than in 70%BWS.

Discussion: As it was described in previous researches [1,2] the stance time and the double-limb support time decreased as the percentage of BWS increased. Therefore subjects were forced to support their body weight and keep the balance on a single limb for longer periods of time. Step width and side-to-side movement of CG were progressively increased from 30% to 70%BWS to maintain the dynamic balance during gait.

Finch et al. [1] described, like in the present study, smaller amplitude of movement in the knee and ankle attributed to the decreased amount of weight supported, mainly at heel strike. Also, the ankle maximum and minimum events appeared early during the gait cycle as the percentage of BWS increased, as Threlkeld et al. reported [2], because ankle movement was less controlled by exoskeleton.

These findings show how it should be taken into account the influence of BWS in a fixed gait pattern reproduced by an exoskeleton, because that could modify the effects and conditions of training using those devices.

References

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