Development of a Controlled Harness System to Increase Flexibility in Balance Testing and Training

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Development of a Controlled Harness System to Increase Flexibility in Balance Testing and Training

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Background
Falling can have devastating effects on older populations; it is one of the leading causes of injury-related deaths in the United States. Balance training has become increasingly prevalent as a method of prevention due to its efficacy in reducing falls and even the fear of falling. Two forms of intervention exist for individuals who need to improve their balance: pro-active and reactive balance training. Pro-active balance training involves movements that are regulated at the discretion of the performer. In reactive balance training, individuals must recover from external disturbances that cause a loss of balance. A harness is an effective tool for reducing the risk of injury including a harness system in balance training not only prevents injury to patients and participants, but it may also encourage patients to challenge themselves throughout the intervention.

Current Harness Systems
Harness systems are useful for training balance in therapy settings. They provide a safe means of implementing reactive balance protocols to prevent falls and injuries. For more frail and vulnerable individuals, harnesses may be used in pro-active balance training as well. Typically, harness systems incorporate either a fall-arrêt harness or a body weight support harness, and can sometimes be both. Fall-arrêt harness systems can catch a person during a fall without supporting the individual’s posture or balance. In contrast, body weight support harnesses can support a selected percentage of the individual’s body weight and is able to maintain that support throughout the patient’s movement. This is beneficial as it allows the proper mechanics of gait to be practiced and re-learned. However, there is a lack of significant evidence regarding the impact the two harness systems have on skill acquisition, motor learning, physical impairments, and psychological factors. Researchers are concerned that fall-arrêt and body weight support harnesses do not pose enough of a challenge and may interfere with the motor learning of balance tasks.

Current Applications
The initial testing using the new controlled harness technology is currently underway and will continue in the upcoming months. Subjects will be recruited from the community; individuals 55 years of age or older with mild balance impairments will be considered for this study. We are particularly interested in post-stroke individuals or individuals with Parkinson’s Disease.

Protocol:
On test day, the subjects will first undergo a series of balance tests. The score calculated for the subject on the miniBEST balance test will dictate the testing parameters used for the subject. We have developed an algorithm to guide the parameters chosen for the subject corresponding to three different score ranges. Once the parameters are determined, the individual will be attached to the harness system and testing will begin. The individual will be slipped unexpectedly, and their reaction will be captured using a software system CORTEX. Their parameters will be adjusted based on their reactions. Testing of the subject will cease if the subject is observed to make three recoveries in a row at the highest level of testing, and no more than 17 slips will be performed in any single session.

A Controlled Harness System
In our lab, we have been working on developing a harness system for which the support parameters may be controlled and adjusted to better gauge its effectiveness in relaening balance. The proposed harness system will have the following capabilities:
- limit the height of descent by a pre-set vertical limit
- provide dynamic partial body weight support
- control how the support system responds to the individual falling
- assist in the return to a standing position through pre-determined thresholds and levels of assistance
- monitor, measure, and record the vertical and horizontal components of the body’s center of mass (COM) movements
- provide feedback to users regarding the support that is provided or other haptic, visual, and auditory cues

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Future Applications
The pilot study currently in progress will provide information about the application of the new motorized harness system and give insight into the possible benefits of employing such a system as a rehabilitation tool in a clinical setting. Results from tests completed with this harness system will be analyzed to understand the role of the motorized harness in a holistic balance training regimen. This harness system will enable balance training and testing modalities that are not currently possible and will thus increase flexibility in training for patients.

Acknowledgments
This work was supported by the Cleveland State University USRA program.

References
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For more information, or to get in contact with the lab, please visit us at:
https://csmotionanalysislab.wordpress.com/