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**2. Abstract**

The protocol utilized a side-by-side split-belt instrumented treadmill to simulate a trip-like perturbation. Compared to previously published methodologies, this new protocol is focused on delivering the perturbation at a precise timepoint during gait. Programmed treadmill belt acceleration profiles are triggered unilaterally at the instant the tripped leg bears 20-25% of the body weight in early stance phase. The belt acceleration profile starts from a comfortable walking speed, followed by a sudden slowdown, then an acceleration, and finally returning to the comfortable walking speed. The slowdown is meant to simulate the foot obstruction and the acceleration reproduces the leg-torso discoordination and the trunk forward thrust during a trip.

**3. Keywords**

fall, trip, stumble, perturbation, disturbance

**4. Guidelines**

This protocol is designed to invoke a destabilizing condition that simulates an unexpected fall event. Using an instrumented treadmill, the protocol enables consistent and accurate delivery of postural perturbation to a test participant who is walking on the treadmill. Reliability of participants’ biomechanical responses to repeated perturbations has been established. The protocol has been further validated for distinguishing fall risk and fall recovery movement patterns between younger and older adults by our research group.

**5. Before Start**

Please double check the setting for fall prevention/participant protection. We strongly suggest a safety harness to be installed and properly tested before applying the protocol to any individual. To ensure participants do not hit the ground, after fitting participants to the harness, we asked them sit in the harness and put their full body weight to it like playing on the swing and bending their knees. We adjusted the tether under this circumstance so that their knees would not hit the ground even in the most severe fall event. The adjusted tether length should not interrupt the participant’s gait. Padding can be added to the supporting struts and handrails to better protect the participants.

In order to run the protocol, a few parameters need to be gathered including participants’ comfortable walking speeds for treadmill walking in m/s (or a designated speed decided by the research team) and their body weight in kg.

**6. Safety Warnings**

Given the protocol is triggered by a vertical ground reaction force during gait, the protocol is not applicable to individuals who are unable to walk on a treadmill. The safety of the individual should be the priority. Additional warning message from the treadmill manufacturer as related to the execution of the protocol is provided below: “Once remote control for the treadmill is enabled, the treadmill can execute immediate full-speed motion based on commands received from the remote source. Please ensure you have proper firewall settings in place to prevent uncommanded treadmill operation. Manual operation of treadmill controls will overwrite and disable remote control.”

**7. Materials**

We suggest that this protocol should only be applied to individuals who can walk independently without assistive device for at least 5 minutes. The suggestion is estimated based on the time required for familiarizing the individual to treadmill walking, fitting for the harness, and completing the protocol.

**8. Equipment**

* Bertec side-by-side split-belt instrumented treadmill (Model ITC-11-20L-4, Bertec Corp., Columbus, OH, USA)
* VICON motion capture system (Oxford Metrics, Oxfordshire, UK) with Software Development Kit (SDK)
* MATLAB version R2017b or newer

**9. Citations**

Sessoms, P.H., Wyatt, M., Grabiner, M., Collins, J.-D., Kingsbury, T., Thesing, N., Kaufman, K., 2014. Method for evoking a trip-like response using a treadmill-based perturbation during locomotion. J Biomech 47, 277-280.

Zhang, F., D'Andrea, S.E., Nunnery, M.J., Kay, S.M., Huang, H., 2011. Towards design of a stumble detection system for artificial legs. IEEE Trans Neural Syst Rehabil Eng 19, 567-577.

**10. Additional Notes**

None.