abstract
This dissertation aimed to evaluate the effectiveness and drawbacks of promising fall prevention strategies in individuals with stroke by rigorously analyzing the biomechanics of laboratory falls and compensatory movements required to prevent a fall. Ankle-foot-orthoses (AFOs) and functional electrical stimulators (FES) are commonly prescribed to treat foot drop. Despite well-established positive impacts of AFOs and FES devices on balance and gait, AFO and FES users fall at a high rate. In chapter 2 (as a preliminary study for chapter 3), solely mechanical impacts of a semi-rigid AFO on the compensatory stepping response of young healthy individuals following trip-like treadmill perturbations were evaluated. It was found that a semi-rigid AFO on the stepping leg diminished the propulsive impulse of the compensatory step which led to decreased trunk movement control, shorter step length, and reduced COM stability. These results highlight the critical role of plantarflexors in generating an effective compensatory stepping response. In chapter 3, the underlying biomechanical mechanisms leading to high risk of falling in long-term AFO and FES users with chronic stroke was studied. It was found that AFO and FES users fall more than Non-users because they have a more impaired lower limb that is not fully addressed by AFO/FES, therefore leading to a more impaired compensatory stepping response characterized by increased inability to generate a compensatory step with paretic leg and decreased trunk movement control. An ideal future AFO that provides dorsiflexion assistance during the swing phase and plantarflexion assistance during the push-off phase of gait is suggested to enhance the compensatory stepping response and reduce more falls. In chapter 4, the effects of a single-session Trip-specific training that has shown promising results in older adults, on the compensatory stepping response of individuals with stroke were evaluated. Trunk movement control was improved after a single session of training suggesting that this type of training is a viable option to enhance compensatory stepping response and reduce falls in individuals with stroke. Finally, a future powered AFO with plantarflexion assistance complemented by a trip-specific training program is suggested to enhance the compensatory stepping response and decrease falls in individuals with stroke.