

## Neuromechanical adaptations in joint stiffness when hopping with a SL-AFO

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**Background and Significance:** Humans hopping on different elastic surfaces in series (Fig. 1), adjust leg stiffness ( $k_{leg}$ ) to maintain system stiffness (leg+surface), primarily by modulating ankle joint stiffness ( $k_{ankle}$ ). When a parallel elastic element is applied at the ankle to assist plantarflexion (Fig. 2),  $k_{leg}$  and total  $k_{ankle}$  (ankle+spring) is conserved. Moreover, biological  $k_{ankle}$  decreases to offset the added stiffness of the spring. We studied the effects of adding a resistive plantarflexion torque in parallel with the ankle. We hypothesized  $k_{leg}$  and total  $k_{ankle}$  would remain invariant and that biological  $k_{ankle}$  would increase to compensate.

**Research Design:** We ran a repeated measures study on 10 subjects hopping in place under three conditions: AFO (control), plantarflexion assist spring-loaded AFO (PA-SLAFO), and a plantarflexion resist SLAFO (PR-SLAFO). We collected kinematic, kinetic, and EMG data at each condition for three frequencies (2.2, 2.4, 2.8 Hz). We analyzed statistics using a Three-Way ANOVA (subject, condition, frequency) with a Bonferroni Post-Hoc test.

**Results & Tentative Conclusions:** Different AFO conditions had no effect on  $k_{leg}$  ( $P > .103$ ). Total  $k_{ankle}$  was maintained for PA-SLAFO, with biological  $k_{ankle}$  decreasing to perfectly compensate. In the PR-SLAFO condition, total  $k_{ankle}$  was greater than expected ( $P < 0.05$ ). Biological  $k_{ankle}$  increased with PR SL-AFO, but was unable to completely compensate for the added resistance. This implies that despite adequate global compensation to maintain  $k_{leg}$ , subjects could not completely compensate for added resistive torque solely at the ankle and had to enlist a multi-joint compensation strategy. We are currently investigating these multi-joint compensation strategies.

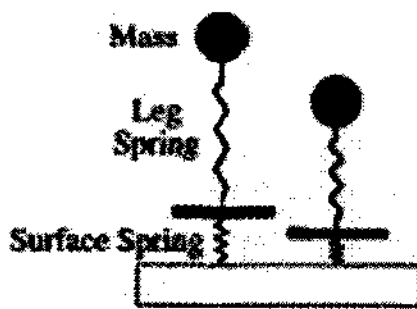


Fig. 1: Spring-Mass System in series with an elastic surface<sup>7</sup>

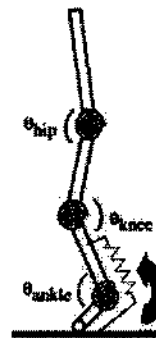


Fig. 2: A spring in parallel with the ankle adding a plantar-flexor torque

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