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Mechanics of bipedal hopping on uneven terrain

For animals that locomote on uneven terrain, the ability to negotiate abrupt surface changes that can impede forward progression and cause instability is critical for survival. The musculoskeletal system mediates such perturbations, but the mechanisms by which the elements of the musculoskeletal system work together to enable dynamic stability under such conditions are still not thoroughly understood. Here, we examine the mechanics in how kangaroo rats Dipodomys Deserti negotiate abrupt changes in surface slope. We collected high-speed video and ground reaction force (GRF) data of kangaroo rats (n=6) hopping bipedally on our variable terrain rotatory treadmill at 1.77m/s under two conditions: 1) level ground hopping, 2) perturbed hopping invoked by an instrumented 12 degree up-sloped wedge. We measured whole body and joint level mechanics observed in bipedal hopping using an inverse dynamics analysis to understand changes with the perturbation. We hypothesized GRFs would be modified to minimize whole body pitch and forward velocity changes. Although preliminary results are consistent with this hypothesis, we observe that the animals maintain forward progression by preemptively encountering the sloped plate with a greater forward velocity to compensate for increase braking impulses caused by altered GRFs, in which this absorption is mediated mostly at the proximal joints. These results are consistent with prior perturbation studies that shows division of labor across the hindlimb functions to maintain forward progression and stability.