Title: Compliant walking appears metabolically advantageous at extreme step lengths

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Compliant walking appears metabolically advantageous at extreme step lengths

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Highlights

- Walking at extreme step lengths results in spontaneous increase of leg compliance.
- Compliant leg walking requires more energy at normal step lengths.
- Normal walking costs increase dramatically at long step lengths.
- Metabolic costs drive the spontaneous change in leg compliance.
- Use of each leg strategy appears as an optimization of energy loss and leg work.

Abstract

Background
Humans alter gait in response to unusual gait circumstances to accomplish the task of walking. For instance, subjects spontaneously increase leg compliance at a step length threshold as step length increases. Here we test the hypothesis that this transition occurs based on the level of energy expenditure, where compliant walking becomes less energetically demanding at long step lengths.

Research question
To map and compare the metabolic cost of normal walking and compliant walking as step length increases.

Methods
10 healthy individuals walked on a treadmill using progressively increasing step lengths (100%, 120%, 140% and 160% of preferred step length), in both normal and compliant leg walking as energy expenditure was recorded via indirect calorimetry. Leg compliance was controlled by lowering the center-of-mass trajectory during stance, forcing the leg to flex and extend as the body moved over the foot contact.

Results
For normal step lengths, compliant leg walking was more costly than normal walking gait, but compliant leg walking energetic cost did not increase as rapidly for longer step lengths. This led to an intersection between normal and compliant walking cost curves at 114% relative step length (regression analysis; r^2=0.92 for normal walking; r^2=0.65 for compliant walking).