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Energy recovery in individuals with knee osteoarthritis

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Objective: Pathological gaits have been shown to limit transfer between potential (PE) and kinetic (KE) energy during walking, which can increase locomotor costs. The purpose of this study was to examine whether energy exchange would be limited in people with knee osteoarthritis (OA).
Methods: Ground reaction forces during walking were collected from 93 subjects with symptomatic knee OA (self-selected and fast speeds) and 13 healthy controls (self-selected speed) and used to calculate their center of mass (COM) movements, PE and KE relationships, and energy recovery during a stride. Correlations and linear regressions examined the impact of energy fluctuation phase and amplitude, walking velocity, body mass, self-reported pain, and radiographic severity on recovery. Paired *t*-tests were run to compare energy recovery between cohorts.
Results: Symptomatic knee OA subjects displayed lower energetic recovery during self-selected walking speeds than healthy controls ($P = 0.0018$). PE and KE phase relationships explained the majority (66%) of variance in recovery. Recovery had a complex relationship with velocity and its change across speeds was significantly influenced by the self-selected walking speed of each subject. Neither radiographic OA scores nor subject self-reported measures demonstrated any relationship with energy recovery.
Conclusions: Knee OA reduces effective exchange of PE and KE, potentially increasing the muscular work required to control movements of the COM. Gait retraining may return subjects to more normal patterns of energy exchange and allow them to reduce fatigue.

Introduction

It is well understood that the movements of the center of mass (COM) of a person during normal walking on a relatively stiff leg (with limited knee flexion) follow the cycle of an inverted pendulum and that this pattern influences the exchange of energy and muscular work required to accelerate and decelerate (strictly defined as positive or negative accelerate) the COM[1–5]. In walking, the stored gravitational potential energy (PE) of the COM is at its highest during midstance, when the kinetic energy (KE) of the COM is at its lowest. As it leaves this midstance position and the COM descends, PE is converted to KE, and the horizontally directed component of KE moves the body forward to land on the contralateral limb. After this footfall, the COM again moves upward (as long as the limb remains relatively straight) driven partly by KE and stores PE that can again be returned as KE at the next step-to-step transition. The efficiency of this energy exchange between PE and KE can be as high as 70% during normal human walking at preferred speeds. When the exchange is efficient, it can reduce the amount of muscular effort needed to accelerate and decelerate the COM[1,6]. Several studies have separately indicated that the metabolic cost of walking is primarily allocated towards raising the COM throughout the gait cycle[7–9]. Thus, this mechanism of exchanging KE and PE may serve to reduce the metabolic cost of locomotion by reducing the muscular effort required to accelerate and decelerate the COM[2].

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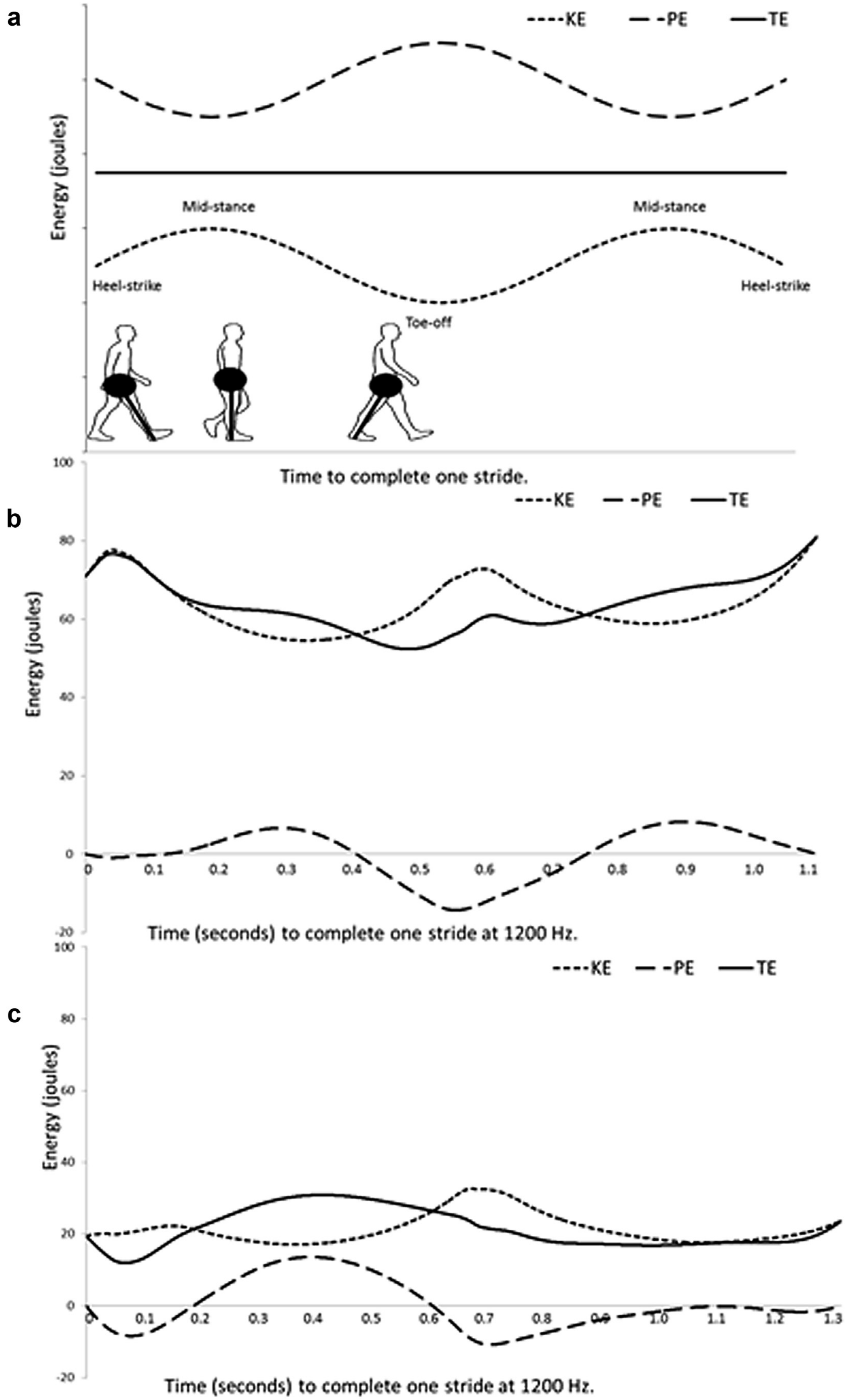

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