A MECHANISM TO LOWER THE KNEE ADDUCTION MOMENT DURING WALKING: GAIT RETRAINING AS INTERVENTION FOR KNEE OA

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INTRODUCTION

The external adduction moment at the knee during walking has been shown to be a strong predictor for medial compartmental knee osteoarthritis (OA) severity (Mündermann et al. 2004) and rate of progression (Miyazaki et al. 2002). It has been reported (Mündermann et al. 2005) that patients with knee OA adopt a gait pattern that involves a more extended knee at heel-strike, a more rapid increase in the ground reaction force, greater lateral ground reaction force, and greater knee and hip abduction moments. It was speculated that this pattern is caused by a lateral shift of the trunk with the goal to control the peak knee adduction moment. This strategy appeared to be successful only in patients with less severe knee OA as these patients had normal knee adduction moments in contrast to patients with more severe knee OA who had higher moments than matched control subjects. If increasing trunk motion would result in similar gait changes and also reduced knee adduction moments, this method of gait retraining could be used as an intervention to reduce medial compartment load in patients with knee OA. The purpose of this study was to test the hypothesis that when walking with increased medio-lateral trunk motion, control subjects will have more extended knees at heel strike, increased knee and hip abduction moments resulting in reduced knee and hip adduction moments compared to normal walking.

METHODS

Nineteen subjects (7 female, 12 male; age: 22.8 ± 3.1 yrs; height: 174.8 ± 9.7 cm; mass: 70.5 ± 16.3 kg) participated in this study after giving written consent in accordance with the Institutional Review Board. None of the subjects had previously been treated for any clinical lower back or lower extremity condition or had any activity-restricting medical or musculoskeletal condition. Subjects performed walking trials of normal gait and increased medio-lateral trunk sway. The degree of sway for the increased trunk sway trials and walking speed were self-selected by the subject. Kinematics and kinetics of each trail was analyzed using the 6-marker-link model, ground reaction force measurements, and limb segment mass/inertia properties, and moments were then normalized to body weight and height (% Bw*Ht) (Schipplein and Andriacchi 1991). Knee angle at heel-strike, loading rate, knee and hip abduction and adduction moments, and lateral ground reaction force were compared between the two conditions using a MANOVA and paired Student's t-tests ($\alpha = 0.01$).

RESULTS

When walking with increased trunk sway, all subjects had greater hip and knee abduction moments and reduced first peak hip and knee adduction moments (Figure 1). With increased trunk sway, subjects also

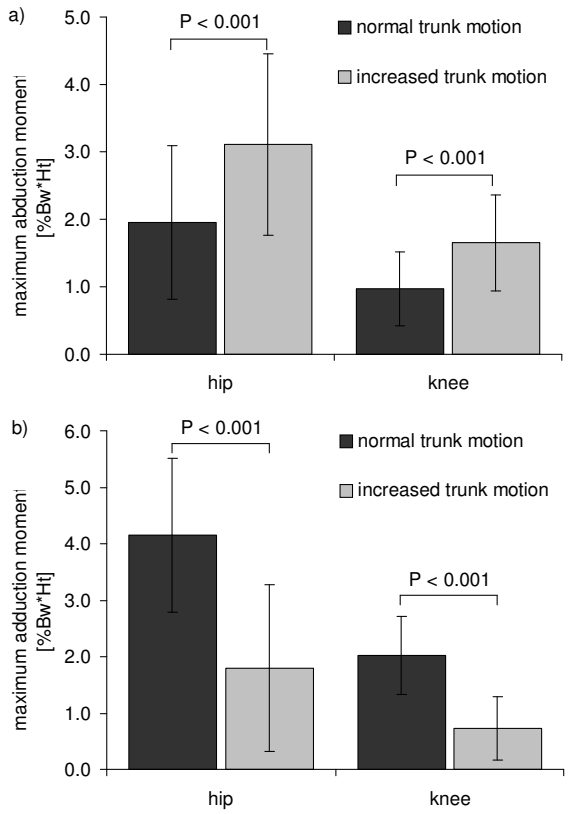

Figure 1: Average (1 standard deviation) external peak hip and knee abduction (a) and adduction (b) moments for walking with two trunk sway conditions (n = 19).

landed with slightly more flexed knees (+3.0°; P=0.009) and similar lateral ground reaction force compared to walking with normal trunk motion. Walking speed was the same for normal and increased trunk sway trials walked at similar speed (1.48 ± 0.17m/s and 1.44 ± 0.15m/s, respectively).

DISCUSSION

The results support the hypothesis that increased trunk sway in healthy subjects leads to similar changes in hip and knee abduction moments as have been reported for patients with knee OA (Mündermann et al. 2005). In contrast to patients with knee OA, this gait pattern resulted in lower knee adduction moments in all healthy subjects. Interestingly, the healthy subjects tested in this study also had similar knee flexion angles at heel-strike, loading rates, and lateral ground reaction forces when walking with increased trunk sway and with normal trunk sway. The combined results of this study and our previous work (Mündermann et al. 2005) suggest that patients with knee OA may utilize a strategy to control the knee adduction moment that includes differences in trunk sway but may be constrained by the muscle strength of hip and trunk stabilizers, and thus is only successfully accomplished by patients with less severe knee OA.

Subjects in this study were instructed to merely increase their medio-lateral trunk sway, and required minimal practice (less than three practice trials) to adopt the gait patterns presented here. Thus, increased trunk sway may be a simple yet effective non-invasive intervention in early knee OA that amplifies patients' natural gait changes leading to a reduction in medial compartment load without secondary changes in gait mechanics such as decreased knee flexion angle at heel-strike or increased ground reaction forces and loading rates that may represent increased loads at other joints.

This result supports the concept of developing new methods for gait retraining of patients with knee OA in the medial compartment of the knee.

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