THE INFLUENCE OF CHRONIC LOW BACK PAIN ON THE SPINE AND HIP JOINT EXCURSIONS AND JOINT TORQUES DURING FORWARD BEND TASKS

Stacey L. Moenter, Nikki J. Vander Wiele, Daohang Sha, Christopher R. France*, and James S. Thomas
School of Physical Therapy, *Department of Psychology, Ohio University, Athens, OH

Introduction

Recent studies by Thomas and Gibson (2007), provide evidence that there are spine and hip to be simultaneous during spine flexion, but sequential during contrast to these findings, Nelson et al. (1995) reported timing between the spine and hip joint motions used during forward bending in subjects with and without a history of low back pain. Spine 22, 552-558. Studies analyzing the spine-hip ratio during the forward bending have concluded that spine movement is predominant in the initial phases of forward flexion, with the hip contributing more in the latter part of the movement. During the return to upright posture, hip movement predominates the initial movement, while the spine contributes more towards the latter part of extension (Lee et al. 1997, Porter et al. 1997, McQuire et al. 1997, Exalto et al. 1994). In these studies, agreement exists as to the gross pattern of movement between the spine and hip, but studies analyzing the timing of these joints is thought to be important. However, data regarding the onset timing of the spine and hip joints provides conflicting results. Several studies report simultaneous onset of the spine and hip motion during forward bending (Paquet et al. 1994, Exalto et al. 1996, Lee et al. 2002, and Porter et al. 1997). However, only Lee et al. (2002) specifically analyzed onset timing. In contrast to these findings, Nelson et al. (1995) reported timing between the spine and hip to be simultaneous during spine flexion, but sequential during the return to upright posture with hip movement preceding that of the spine. A recent study by Thomas and Gibson (2007), provides evidence that there are clear differences in onset timing of the spine and hip during natural reaching movements. Therefore, the purpose of this study was to examine the influence of chronic low back pain on the timing and excursions of the spine and hip in participants performing a forward bend task. Additionally, we examined the peak-to-peak joint torques in this cohort.

Methods

Twelve subjects with chronic low back pain and twenty healthy controls matched according to age, height, weight, and gender performed two trials of the forward bending task. Subjects were instructed to bend forward as far as possible while keeping the knees extended, and then return to an upright posture. Participants performed the forward bend test at a self-selected speed. Motions of the trunk, pelvis, and limb segments were recorded using a T-camera Vicom MX-13 System. An Euler angle sequence was used to derive the three dimensional joint motions of the lumbar spine (i.e. motion of the thorax relative to the pelvis), and right hip (i.e. motion of the pelvis relative to the right femur). For the joint kinematics, peak-to-peak excursion of the hip and spine were calculated. Using custom algorithms, onset timing of the spine and hip was defined as the joint angle at which angular velocity exceeded 0.25 deg/s. The spine hip latency was determined by subtracting hip joint onset from spine joint onset at same height below the pelvis. Hip and spine latency were also determined using a 15 segment inverse dynamic model developed in this lab using Matlab Simulink. The peak-to-peak spine and hip joint torques were extracted from the time series data.

Data Analysis

Univariate ANOVA's were used to analyze the effects of group on the peak-to-peak excursions of the spine and hip joints, the spine-hip ratio, and joint torques of the spine and hip.

Results

Figure 1 displays time series kinematic data of a typical participant with chronic low back pain and a matched healthy control to illustrate the spine and hip joint motions used during this task. Subjects in both groups used more spine motion and less hip motion when performing the forward bend test. Further, Figure 2 illustrates the time series of hip and spine velocity of a participant with and without a history of low back pain. This figure clearly indicates that spine motion preceded hip motion for both subjects. Similarly, the stick figures shown in Figure 3 provide insight into the differences in the excursions of the spine and hip joints in these two groups. The participant with low back pain illustrated in Figure 3A used less spine motion, less hip motion, more flexion at the knee, and the participant was unable to touch the ground. In contrast, Figure 3B shows that the matched healthy control used more spine motion, less hip motion, and was able to touch the ground. In fact, on average, participants with chronic low back pain had significantly less spine motion than matched healthy controls (P=.075, p=.26) (Figure 4). However, there were no group differences in hip joint motion (P=.02, p=.15), or in the spine-hip ratio (P=.001, p=.96). Figure 5 shows that there were no significant group differences in the spine-hip ratio during the forward bend task. There were also no group differences in the onset timing of the spine and hip joints (P=.838, p=.85). On average, in the forward bend movement spine motion preceded hip motion by 77ms. Additionally, there was no group effect on the peak-to-peak joint torques of the lumbar spine (P=.53, p=.46), or hip joints (P=.56, p=.49) as presented in Figure 6.

Conclusions

During constrained forward bending tasks, subjects with chronic low back pain use less lumbar flexion, but had no differences in hip joint excursion, spine-hip ratio or onset timing of the spine and hip. Perhaps more importantly, the reduction in spine motion did not appear to reduce the gross muscle torque on the lumbar spine.

This research was supported by The National Institutes of Health Grant ROI-HD045512 to J.S. Thomas

References