The Effect of Initial Posture on The Performance of Multi-Joint Reaching Tasks: A Comparison of Joint Excursions Between Individuals With and Without Chronic Low Back Pain

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Figure 1

Introduction

Low back pain (LBP) is a major healthcare concern and economic burden worldwide. It is one of the most common reasons individuals seek medical care secondary to the common cold (Hertling, 2006). 80% of the population will eventually experience an episode of LBP at one point in their life and 50% will experience a recurrent episode (Walker 2000; Jones, 2005). Although there have been a multitude of studies involving chronic LBP, fundamental questions remain unanswered. Prior research has explored differences in standing or sitting postures as well as ergonomics of different postural conditions, however few studies have evaluated movement patterns in regards to standing and sitting postures during dynamic conditions in conjunction with comparing both the healthy and LBP population. Therefore, the purpose of this study was to determine the effect of initial posture (i.e. standing vs. sitting) on movement strategy in individuals with and without chronic LBP during a reaching paradigm. The first question investigated was: how does initial posture influence trunk kinematics during a reaching paradigm? The second question addressed was: is there a difference in trunk kinematics displayed by individuals with chronic LPB compared to those individuals without LBP?

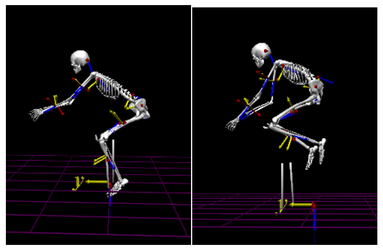
Methods

Thirty-six participants between the ages of 18-37 (18 healthy, 18 chronic LBP) were recruited for the study. Participants performed three trials of each reaching movement; first with the right hand, then with the left hand, and finally with both hands to the high, middle, and low target across two conditions: 1) standing and 2) sitting for a total of 54 reaching trials (See Figure 1&2). In the sitting condition, participants were seated in a Balans Chair, which was chosen because its ergonomic design provided elimination of the DOF of the ankle and knee joints without altering the neutral erect posture that individuals display in standing. The height and AP distance of the chair was adjusted so that the height of the greater trochanters and target distance was kept constant between the sitting and standing conditions, the only difference being the elimination of the ankle and knee DOF. Prior to beginning the reaching paradigm, the following measurements were taken: participant height, trunk length, pelvic length, hip height, and arm length. Target location was determined based on these measurements in order make relative reach distance constant across participants. For example, each participant could theoretically reach the high target with their upper extremity fixed in 90° of shoulder flexion, hips flexed 15° with respect to the vertical plane with no movement of the spine, knees, or ankle. Middle and low targets could be reached with 45° of hip flexion and 60° of hip flexion, respectively (See Figure 3). For the reaching trials, a fork sensor was used to detect the initiation of the reach and the point at which the participant returned from the target. The "go" signal was a green light emitting diode and an accompanying audible beep at which the participants would break contact with the fork sensor and make contact with the target. Target contact was determined by interruption of a laser beam crossing the target. The participants remained at the target for 2 seconds until a red light emitting diode flashed with an accompanying audible beep to signal the participant to return to their neutral upright position with their index finger returned to the fork sensor. Motion of the trunk and limb segments was recorded using Motion Monitor, a magnetic based kinematic system.

Table 1

	LBP n=18	Healthy Persons
Age	22.17±4.18	23.78±3.70
Height (cm)	170.06±9.58	169.67±8.55
Weight (kg)	67.35±16.35	67.35±16.35

Figure 2



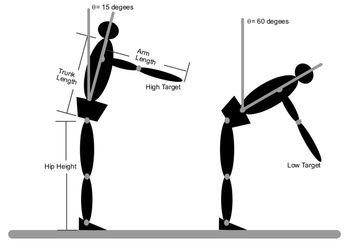


Figure 3: Targets were positioned in the mid-sagittal plane such that the participant could reach the high, middle, and low targets with 15º ,45°, and 60º of hip flexion respectively while maintaining 90º of shoulder flexion.

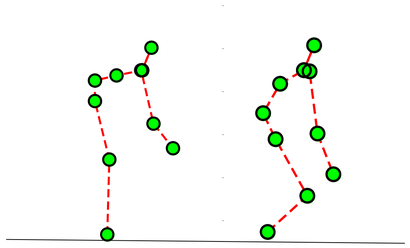
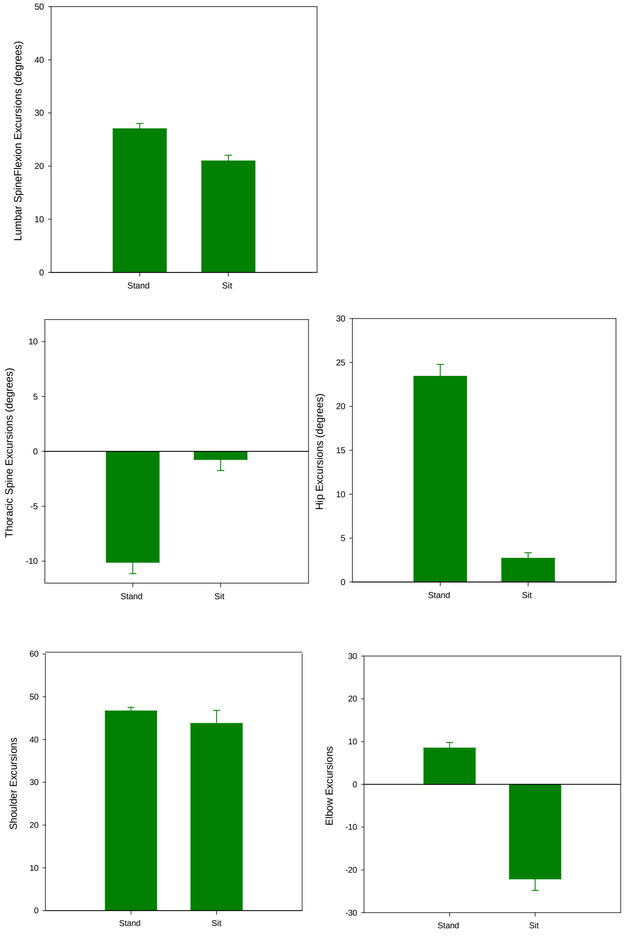


Figure 5: Reaching to the low target for a representative chronic LBP participant in the standing position vs. sitting position

Figure 4: There was a significant effect of initial posture on lumbar, thoracic, hip, and elbow joint excursions in all participants



Data Analysis

Mixed Model ANOVAs were used to analyze joint excursions across the conditions of group and initial posture.

Results

There was no significant difference between participants with and without chronic low back pain in terms of age, height, and weight (See Table 1). The two groups also had an equal number of male and female participants (10 females, 8 males). There was a significant main effect of initial posture on thoracic spine excursions ($F=81.76$ $p< 0.05$), lumbar spine excursion ($F=31.99$, $p< 0.05$), hip excursions ($F=184.431$ $p< 0.05$), and elbow joint excursions. While initial posture influenced lumbar excursions there was no main effect of group on lumbar flexion. Contrary to expectations, participants exhibited greater lumbar flexion during standing reaching tasks than during sitting reaching tasks 27.0±1.0° vs. 21.0±1.0°, respectively. Figure 5 further illustrates the effect of initial posture on lumbar excursions for a representative chronic LBP participant reaching to the low target. While in the standing position, participants tended to flex their lumbar spine and extend their thoracic spine to reach the target. In the sitting position, participants exhibited less lumbar flexion and maintained their thoracic spine in near neutral extension. Additionally, less hip flexion excursion was observed during the sitting trials compared to standing trials. In order to compensate for this decreased spinal excursion in the sagittal plane, participants adopted an alternative movement strategy of spinal rotation in order to reach the targets in the sitting position (See Figure 6)

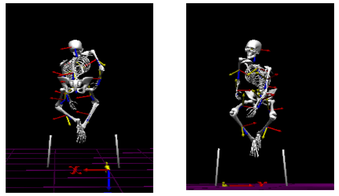


Figure 6

Conclusions

The present study examined the effect of initial posture on the performance of multi-joint reaching tasks and compared the joint excursions between individuals with and without chronic LBP. In summary, this study concluded that alternative movement strategies occur when comparing reaching trials in a standing vs. sitting posture in individuals with and without chronic LBP. However this study revealed that there was a there was no significant effect of group on joint excursions. LBP is one of the most prevalent musculoskeletal problems in the U.S. (Jones, 2005; Walker 2000; Dagenais, 2008). More research needs to be conducted to examine the influence of initial posture on movement patterns between individuals with chronic LBP compared to healthy individuals without LBP. It is important to understand and gain further clarification on whether individuals with chronic LBP adapt their movement strategy under different postural conditions and if those adaptations differ from those observed in individuals without LBP. Further research needs to be conducted with a more symptomatic group of LBP sufferers in order to identify any differences in movement patterns during forward reaching tasks that may not have been evident in the participants of this study.

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