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Asymmetry of lumbopelvic movement patterns during active hip abduction is a risk factor for low back pain development during standing

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ABSTRACT

An induced-pain paradigm has been used in back-healthy people to understand risk factors for developing low back pain (LBP) during prolonged standing. We examined asymmetry of lumbopelvic movement timing during a clinical test of active hip abduction in back-healthy people who developed LBP symptoms during standing (Pain Developers; PDs) compared to back-healthy people who did not develop LBP symptoms during standing (Non Pain Developers, NPDs). Participants completed the hip abduction test while movement was recorded with a motion capture system. Difference in time between start of hip and lumbopelvic movement was calculated (startdiff). PDs moved the lumbopelvic region earlier during left hip abduction than right hip abduction. There was no difference between sides in NPDs. In PDs, the amount of asymmetry was related to average symptom intensity during standing. Asymmetric lumbopelvic movement patterns may be a risk factor for LBP development during prolonged standing.

1. Introduction

Epidemiological studies have shown that jobs requiring prolonged standing are associated with increased reports of LBP (Andersen, Haahr, & Frost, 2007; Macfarlane et al., 1997; Picavet & Schouten, 2000; Roelen, Schreuder, Koopmans, & Groothoff, 2008; Tissot, Messing, & Stock, 2009). Recent studies have used an induced-pain paradigm to understand characteristics that predispose a person to LBP development during prolonged standing (standing paradigm) (Gregory, Brown, & Callaghan, 2008; Gregory & Callaghan, 2008; Marshall, Patel, & Callaghan, 2011; Nelson-Wong, Alex, Csepe, Lancaster, & Callaghan, 2012; Nelson-Wong & Callaghan, 2010a, 2010b, 2010c, 2014; Nelson-Wong, Flynn, & Callaghan, 2009; Nelson-Wong, Gregory, Winter, & Callaghan, 2008; Nelson-Wong, Howarth, & Callaghan, 2010). The paradigm consists of back-healthy people (BHP) standing for 2 h while performing simulated, light work tasks. Participants rate their LBP symptom intensity on a 100 mm visual analogue scale (VAS) at baseline and every 15 min throughout the 2 h. Based on their VAS

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rating, participants are classified either as a pain developer (PD) or a non-pain developer (NPD). Across previous studies, 28–71% of participants have been classified as PDs. The standing paradigm has been shown to be reliable and valid (Nelson-Wong & Callaghan, 2010a, 2010b, 2010c; Sorensen, Johnson, Callaghan, George, & Van Dillen, 2014).

One area of investigation in which differences between PDs and NPDs have been identified is in activation patterns of the hip and trunk muscles during standing (Nelson-Wong & Callaghan, 2010a, 2010b, 2010c; Nelson-Wong et al., 2008). Specifically, compared to NPDs, PDs displayed a greater magnitude of co-contraction of bilateral gluteus medius muscles during the first 30 min and the final 30 min of standing (Nelson-Wong & Callaghan, 2010a, 2010b, 2010c). In addition, PDs were more likely than NPDs to develop an episode of LBP in the 3 years following participation in the standing paradigm (Nelson-Wong & Callaghan, 2014). The authors suggested that the PDs may be a subclinical group that is different from the NPDs prior to LBP symptom development.

Given the differences between PDs and NPDs in hip muscle activation during standing, a clinical movement test was developed to challenge frontal plane trunk control during hip abduction (Nelson-Wong et al., 2009). The purpose of the test was to screen BHP for risk of developing LBP during standing. The screening test was an active hip abduction movement performed in side lying. One examiner scored the person's movement based on visual assessment. Defined criteria were used to guide the examiner's judgments. The scoring criteria the examiner used quantified how well the participant maintained alignment of the trunk and pelvis in the frontal plane during the movement. Data from the limb with the poorer performance score were used for analyses. The authors reported that, compared to NPDs, PDs displayed decreased control of the trunk during the hip abduction test. Thus, the clinical test of active hip abduction discriminated between PDs and NPDs (Nelson-Wong et al., 2009). In addition, Marshall et al. reported that PDs had decreased hip abductor endurance compared to NPDs prior to participation in the standing paradigm (Marshall et al., 2011). The differences between PDs and NPDs suggest differences (1) are present before LBP development, and (2) may put some people at risk for LBP under specific loading conditions.

The trunk movement differences between PDs and NPDs during the hip abduction test are particularly interesting because some of the clinical movement tests used to classify people with LBP into subgroups are intended to identify deficits in lumbopelvic control (Van Dillen et al., 1998; Van Dillen et al., 2003a, 2003b; Van Dillen, Maluf, & Sahrmann, 2009). The LBP subgroups identified are named for the consistency of responses (symptoms and signs) with clinical tests associated with one or more types of spinal loading (e.g. rotation, extension, flexion). Interestingly, one clinical LBP subgroup, the rotation with extension subgroup (RotExt), reports an increase in LBP symptoms earlier during standing than other LBP subgroups (unpublished data). People are diagnosed in the RotExt subgroup based upon reports of increased symptoms with movements and postures during clinical tests that result in extension or rotation loading on the lumbar spine (Maluf, Sahrmann, & Van Dillen, 2000; Van Dillen et al., 2003a, 2003b) and reports of decreased symptoms when the extension or rotation loading is modified (Van Dillen et al., 2003a, 2003b, 2009). The RotExt subgroup also displays asymmetric lumbopelvic movement patterns during clinical tests of trunk and hip movements (Gombatto, Collins, Engsberg, Sahrmann, & Van Dillen, 2007; Van Dillen, Gombatto, Collins, Engsberg, & Sahrmann, 2007). The asymmetric movement patterns are associated with an increase in the person's LBP symptoms (Gombatto et al., 2007; Van Dillen et al., 2003a, 2003b, 2007, 2009). Given the findings related to the RotExt clinical LBP subgroup we reasoned that BHP that develop LBP symptoms during standing may have similar characteristics to people in the RotExt subgroup. In support of this logic we have reported that compared to NPDs, PDs displayed increased lumbar lordosis in standing (Sorensen, Norton, Callaghan, Hwang, & Van Dillen, 2015). Prior studies have documented that people in the RotExt subgroup display increased lumbar lordosis in standing compared to people in another LBP subgroup and BHP (Norton, Sahrmann, & Van Dillen, 2004). It currently is not known, however, if the PDs would display asymmetric timing of lumbopelvic movement during the hip abduction test as the RotExt subgroup does during clinical movement tests. In addition, it is not known if the asymmetry would be related to a PD's LBP symptom intensity.

The purposes of this study were to examine the (1) asymmetry of timing of lumbopelvic movement during the active hip abduction test in PDs compared to NPDs, and (2) association between the magnitude of asymmetry and the LBP symptom intensity reported during standing by the PDs. We hypothesized that PDs would display larger right to left asymmetry in timing of lumbopelvic movement during the active hip abduction test than NPDs, and the amount of asymmetry would be related to LBP intensity reported by PDs. The findings from this study potentially could provide evidence that BHP that develop LBP symptoms during standing have lumbopelvic movement patterns that are similar to a subgroup of people who already have clinical LBP and complain of symptoms during standing (RotExt subgroup). Similar asymmetric movement patterns between the PDs and the RotExt subgroup would suggest that the movement pattern is present prior to a person developing clinical LBP, and is a potential risk factor for initial LBP development if the person is exposed to a specific type of loading, i.e., prolonged standing.

2. Methods

2.1. Participants

Fifty-seven BHP (28 female, 29 male) participated in the study. The sample includes the same participants from previous reports comparing lumbar curvature in PDs and NPDs (Sorensen et al., 2015) and the relationship of LBP symptom