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Postural stability deficits during the transition from double-leg stance to single-leg stance in anterior cruciate ligament reconstructed subjects



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ABSTRACT

The goal of this study was to evaluate postural stability during the transition from double-leg stance (DLS) to single-leg stance (SLS) in anterior cruciate ligament reconstructed (ACLR) ($n = 20$) and non-injured control subjects ($n = 20$). All ACLR subjects had fully returned to their pre-injury sport participation. Both groups were similar for age, gender, height, weight, body mass index and activity level. Spatiotemporal center of pressure outcomes of both legs of each subject were measured during the transition from DLS to SLS in eyes open and eyes closed conditions. Movement speed was standardized. The center of pressure displacement after a new stability point was reached during the SLS phase was significantly increased in the ACLR group compared to the control group in the eyes closed condition ($P = .001$). No significant different postural stability outcomes were found between the operated and non-operated legs. In conclusion, the ACLR group showed postural stability deficits, indicating that these persons may have a decreased ability to stabilize their body after the internal postural perturbation created by the transition from DLS to SLS. The non-operated leg may not be the best reference when evaluating postural stability of the operated leg after ACLR, as no differences were found between legs.

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1. Introduction

Anterior cruciate ligament (ACL) reconstruction continues to be the standard procedure for ACL-injured athletes who wish to return to sport activities (Marx, Jones, Angel, Wickiewicz, & Warren, 2003; Mather et al., 2013). Despite new insights in risk factors and preventive strategies, the number of ACL reconstructions in the United States appears to increase annually (Lyman et al., 2009; Mall et al., 2014). Even more concerning are the findings that only 55% of athletes return to competitive sport and only 65% of athletes return to their pre-injury level of sport after ACL reconstruction (Arderm, Taylor, Feller, & Webster, 2014), while those athletes who are able to return to sport are at increased risk to sustain ipsilateral and contralateral ACL (re-)injuries (Paterno, Rauh, Schmitt, Ford, & Hewett, 2012; Sward, Kostogiannis, & Roos, 2010; Wright, Magnussen, Dunn, & Spindler, 2011). Because of these inferior patient related outcomes, and high social and economical costs associated with these injuries (Mather et al., 2013), it is essential to gain more insight in the potential modifiable factors contributing to an increased re-injury risk after ACL reconstruction (Hewett, Di Stasi, & Myer, 2013). One prospective study has reported a deficit in postural stability to be one of the predictors of a second ACL injury (Paterno et al., 2010). This is of particular concern, as a recent literature review indicated a trend toward impaired postural stability in subjects following ACL reconstruction (Howells, Arderm, & Webster, 2011). Furthermore, these postural stability deficits may also exist in the non-operated leg after unilateral ACL reconstruction (Hoffman, Schrader, & Kocaja, 1999).

Previous studies investigated postural stability in ACL reconstructed (ACLR) subjects mainly by using a single-leg stance (SLS) task, thereby only focusing on the SLS phase when standing on a fixed force plate with the operated leg. However, the criteria to determine the exact start of the SLS phase have been defined subjectively (Harrison, Duenkel, Dunlop, & Russell, 1994; Hoffman et al., 1999; Mohammadi et al., 2011) or were undefined (Bonfim, Jansen Paccola, & Barela, 2003; Henriksson, Ledin, & Good, 2001; Howells et al., 2013; Shiraiishi et al., 1996; Zouita Ben, Zouita, Dziri, & Ben Salah, 2009). Before standing on one leg, a person moves first toward the opposite direction with a certain maximum deviation (contralateral push-off movement). The spatiotemporal characteristics of this contralateral push-off movement when transitioning from double-leg stance (DLS) to SLS may influence postural stability outcomes when standing on one leg (Dingenen, Staes, & Janssens, 2013). Ignoring this transitional movement, and only using a non-standardized SLS phase might have contributed to the mixed outcomes reported in previous literature. Therefore, the need for continuing research on postural stability following ACL reconstruction with clear and standardized methodologies was emphasized (Howells et al., 2011).

Recently, a new method was developed to measure postural stability during the transition from DLS to SLS (Dingenen, Staes, et al., 2013). This method allows evaluating the functional ability to effectively stabilize one's body before, during and after the initiation of a voluntary movement in a standardized manner. Using this method, Dingenen, Staes, et al. (2013) showed that the duration of the contralateral push-off movement was significantly increased in subjects with chronic ankle instability compared to non-injured control subjects when moving at their own preferred speed. The center of pressure (COP) displacement after a new stability point was reached during the SLS phase was the most discriminative outcome between groups. The ability to effectively shift weight from DLS to SLS has not been tested previously on an ACLR population. The analysis of the performance of both legs during this weight-shifting task may increase our understanding how posture is controlled after ACL reconstruction and allow refining rehabilitation strategies.

The purpose of the present study was to evaluate postural stability during the transition from DLS to SLS in ACLR subjects and non-injured control subjects. The first hypothesis was that ACLR subjects have an increased COP displacement after a new stability point is reached during the SLS phase compared to non-injured control subjects. Our second hypothesis was that postural stability outcomes are not significantly different between the operated and non-operated leg of the ACLR group. A part of this work was presented previously in an abstract form at the IOC World Conference Prevention of Injury & Illness in Sport, Monaco 2014 (Dingenen, Janssens, Claes, Bellemans, & Staes, 2014).

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