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Short communication

Knee kinematics and kinetics during shuttle run cutting: Comparison of the assessments performed with and without the point cluster technique

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ABSTRACT

The differences between the assessments performed with and without the point cluster technique (PCT) for knee joint motions during the high-risk movements associated with non-contact anterior cruciate ligament (ACL) injuries have not been reported. This study aims to examine the differences between PCT and non-PCT assessments for knee joint angles and moments during shuttle run cutting. Fourteen high school athletes performed a maximal effort shuttle run cutting task. Motion data were collected by an 8-camera motion analysis system at 200 Hz, and ground reaction force data were recorded using a force plate at 1000 Hz. In both PCT and non-PCT approaches, the knee joint angles were calculated using Euler angle rotations, and the knee joint moments were obtained by solving the Newton–Euler equations using an inverse dynamics technique. For the extension/flexion angle, good agreement was measured between PCT and non-PCT assessments. The abduction angle obtained in the non-PCT assessment was smaller than that obtained with the PCT. An internal rotation angle was obtained in the PCT assessment, whereas a small external rotation angle was obtained in the non-PCT assessment. For the knee joint moments, good agreement between PCT and non-PCT assessments was observed for all the components. The differences in the knee joint angles were attributed in part to the differences in the position of the medial femoral epicondyle. The results suggest that the ACL injury risk during shuttle run cutting is estimated lower in the non-PCT assessment than in the PCT assessment.

1. Introduction

Knee abduction, internal rotation, and anterior tibial translation are associated with non-contact anterior cruciate ligament (ACL) injuries (Hewett et al., 2005; McLean et al., 2004; Olsen et al., 2004). Reinschmidt et al. (1997) used both skin and bone markers to calculate the knee joint angles during running; they concluded that measurement of knee rotations other than extension/flexion may be affected with substantial errors when using skin markers. Peters et al. (2010) reviewed the available literature and concluded that soft tissue artifacts reach in the vicinity of 40 mm for some areas of the thigh, and up to 15 mm on the shank. Andriacchi et al. (1998) reported that the use of the point cluster technique (PCT), which employs marker clusters on the thigh and shank for estimating movements of the femur and tibia, yields measurements consistent with the actual bone movements during walking. While the PCT has been used in a number of studies (Alexander and Andriacchi, 2001; Koo and Andriacchi, 2008; Ngai and Wimmer, 2009), the kinematics based on the PCT were often unsatisfactory (Carman and Milburn, 2006; Cereatti et al., 2006; Senesh and Wolf, 2009; Taylor et al., 2005).

The knee joint kinematics during high-risk movements associated with non-contact ACL injuries (i.e., landing and cutting) have been examined using PCT (Ishii et al., 2009; Nagano et al., 2007, 2009). Although knee joint kinetic analysis is useful for studying the mechanisms of non-contact ACL injuries, few studies (Ishii et al., 2009) have used PCT to determine the knee joint kinetics during high-risk movements. PCT has also not been used to assess knee joint motions during shuttle run cutting, a high-risk movement. As one of the criteria used to evaluate the effect of PCT in estimation of knee joint motions during high-risk movements, determining the differences between the assessments performed using PCT and those performed without using PCT (PCT and non-PCT assessments) is considered useful. The objective of this study was to examine the differences between PCT and

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