INTRODUCTION:

Though the exact mechanism of non contact anterior cruciate ligament (ACL) has not been fully clarified, several recent studies have suggested individuals who land with a stiff landing profile, defined as reduced knee flexion angles, may be at higher risk of ACL injury than individuals who land more soft [1,2]. The concepts and theories developed from these and other non-contact ACL injury studies have contributed to the development of performance based ACL injury prevention training programs [3,4]. A major component of these programs is neuromuscular training, in which individuals are trained to land with increased knee flexion angles. Though these programs have been shown to be effective in reducing the incidence of ACL injury of female athletes, the specific mechanisms by which injury risk is reduced has not been determined. The purpose of the current study is to measure tibio-femoral kinematics of the knee during soft and stiff landings. We hypothesize that stiff landings will exhibit larger anterior tibial translation (ATT), internal rotation, and valgus angle, thus placing individuals at higher risk of ACL injury.

METHODS:

Eleven healthy subjects (6M, 5F; age 29±6.4yrs) completed stiff and soft drop landings from a height of 40cm inside a biplane fluoroscopy system. In addition, Subjects completed a seated, unloaded knee extension task. Fluoroscopy images were collected for one trial from each task, and were analyzed at 100 Hz. Fluoroscopy data was then tracked using MBRSA (Medis Specials, Leiden, Netherlands, Fig. 1). Knee kinematics were calculated as described by Grood & Suntay [5]. Each subject received verbal instruction for soft and stiff landings which was similar to the instructions outlined in ACL injury prevention programs.

RESULTS:

Average knee flexion angle was 70% larger for soft landings than for stiff (p<0.001), however average and maximum anterior tibial translation (AntTibTr), internal rotation (IntRot), and valgus (Valgus) were all similar between soft and stiff landings (Table 1, Figure 2). No gender or task*gender interaction effects were noted for the variables, though there was a trend for maximum valgus angle to be larger in females than males when averaged across tasks (Females: 1.54±1.21; Males: 0.67±0.92; p=0.08).

![Figure 1: Example of tracking analysis using MBRSA.](image)

![Figure 2: Tibio-femoral kinematics for soft and stiff landings.](image)

DISCUSSION:

Previous literature has suggested that subjects who land more upright, or stiff, are more prone to ACL injury [1,2]. However, results from the current investigation suggest that stiffer landings alone do not make the knee more prone to ACL injury as defined by greater ATT, internal rotation, or valgus angles. Rather, in this controlled setting, healthy non-valgus landers were able to adequately control tibio-femoral motion, regardless of the stiffness of the landing.

Despite the apparent effectiveness of verbal cues and ACL training programs to reduce the incidence of non-contact ACL injury [3,4], rotations and translations commonly associated with ACL injury were not different between soft and stiff landings in the current study. These results imply that stiff landings, as defined by knee flexion angle alone, do not necessarily increase the demand on the ACL. However, it is important to recognize that the landing tasks executed in the current study were completed in a safe and controlled manner, by individuals who were not at high risk of ACL injury. It is possible that although stiff landings alone do not result in greater tibial translation with respect to stiff landings, when coupled with extreme valgus or internal rotation, may be predictive of ACL injury.

REFERENCES:


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