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Home > [Journal of Athletic Training](#) > [January/February 2009](#) > The Relationships Among Sagittal-Plane Lower Extremity Moments: Implic...

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### Original Research

## The Relationships Among Sagittal-Plane Lower Extremity Moments: Implications for Landing Strategy in Anterior Cruciate Ligament Injury Prevention

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### Abstract

**Context:** Excessive quadriceps contraction with insufficient hamstrings muscle cocontraction has been shown to be a possible contributing factor for noncontact anterior cruciate ligament (ACL) injuries. Assessing the relationships among lower extremity internal moments may provide some insight into avoiding muscle contraction patterns that increase ACL injury risk.

**Objective:** To examine the relationships of knee-extensor moment with ankle plantar-flexor and hip-extensor moments and to examine the relationship between knee moment and center of pressure as a measure of neuromuscular response to center-of-mass position.

**Design:** Cross-sectional study.

**Setting:** Applied Neuromechanics Research Laboratory.

**Patients or Other Participants:** Eighteen healthy, recreationally active women (age = 22.3 ± 2.8 years, height = 162.5 ± 8.1 cm, mass = 57.8 ± 9.3 kg).

**Intervention(s):** Participants performed a single-leg landing from a 45-cm box onto a force plate. Kinetic and kinematic data were collected.

**Main Outcome Measure(s):** Pearson product moment correlation coefficients were calculated among the net peak knee-extensor moment (KEMpk), sagittal-plane ankle (AM) and hip (HM) net internal moments, and anterior-posterior center of pressure relative to foot center of mass at KEMpk (COP).

## Volume 44, Issue 1 (January/February 2009)

[◀ Previous](#) [Next >](#)



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**Results:** Lower KEMpk related to both greater AM ( $r = -0.942$ ,  $P < .001$ ) and HM ( $r = -0.657$ ,  $P = .003$ ). We also found that more anterior displacement of COP was related to greater AM ( $r = -0.750$ ,  $P < .001$ ) and lower KEMpk ( $r = 0.618$ ,  $P = .006$ ).

**Conclusions:** Our results suggest that participants who lean the whole body forward during landing may produce more plantar-flexor moment and less knee-extensor moment, possibly increasing hip-extensor moment and decreasing knee-extensor moment production. These results suggest that leaning forward may be a technique to decrease quadriceps contraction demand while increasing hamstrings cocontraction demand during a single-leg landing.

**Keywords:** [quadriceps muscle contraction](#), [hamstrings muscle contraction](#)

Yohei Shimokochi, PhD, ATC, contributed to conception and design; acquisition and analysis and interpretation of the data; and drafting, critical revision, and final approval of the article. Sae Yong Lee, PhD, ATC; Sandra J. Shultz, PhD, ATC, FNATA, FACSM; and Randy J. Schmitz, PhD, ATC, contributed to conception and design, analysis and interpretation of the data, and critical revision and final approval of the article.

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top ▲