NATA RESEARCH & EDUCATION FOUNDATION

Grant Information Summary

The Identification of Biomechanical Predictors of Lower Extremity Energy Absorption

Practical Significance

This investigation demonstrated that landing profiles consistent with greater anterior cruciate ligament (ACL) injury risk may be predicted using biomechanical factors that are modifiable; and that these factors should be specifically targeted in ACL injury prevention programs.

Background

Greater total sagittal plane energy absorption during the 100 ms immediately following ground contact (INI EA) is indicative of a landing profile that likely results in greater ACL loading due to sagittal plane mechanisms. However, it is unknown if modifiable biomechanical factors are predictive of total INI EA.

Objective

To identify modifiable biomechanical predictors of total INI EA.

Design & Setting

This was a cross-sectional study design conducted in the Neuromuscular Research laboratory at the University of North Carolina at Chapel Hill.

Subjects

Seventy-seven (40 males, 37 females) healthy, recreationally active volunteers (Age = 20.8 ± 2.2 years; Height = 174.4 ± 9.6 cm; Mass = 70.3 ± 16.2 kg).

Measurements

Peak strength and electromyographic (EMG) amplitudes were measured during hip and knee extension, knee flexion, and ankle extension (plantarflexion) maximal voluntary isometric contractions (MVIC). Dominant limb EMG and three-dimensional kinematics and kinetics were assessed using an electromagnetic motion capture system and a force plate as subjects performed five double-leg jump landings. During this task, individual joint energy absorptions were calculated by integrating the negative portions of the net power curves of each joint ($P = M \times \omega$) during the 100 ms immediately following initial contact (IC). These joint energy absorptions were then summated to compute total INI EA. Sagittal plane hip, knee, and ankle angles at IC; sagittal plane angular displacements during the loading phase; and EMG amplitudes from 50 ms before to 100 ms after IC, normalized to %MVIC, were also calculated. During data screening, four participants were identified as outliers on at least one outcome measure and excluded from further analysis. Principal components analysis, used to perform factor reduction of the fourteen biomechanical measures (i.e. strength, EMG, angles at IC, and angular displacements), identified five principal components for which component scores were generated and entered into a regression model to predict total INI EA.

Results

Greater total INI EA was predicted by greater scores for PC1, characterized by greater ankle extension and lesser knee and hip flexion at IC, and greater ankle flexion displacement (Adjusted $R^2 = 0.056$, $p = 0.024$).

Conclusions

Lesser hip and knee flexion at IC, greater ankle extension at IC, and greater ankle flexion displacement during landing is predictive of greater total INI EA. While the total variance explained by this model was small, the results suggest that increasing hip, knee, and ankle flexion at IC may be a strategy to decrease ACL strain resulting from sagittal plane loading mechanisms during jump landings.

Publication & Presentation List

Norcross MF, Lewek MD, Padua DA, Shultz SJ, Weinhold PS, Blackburn JT. Modifiable biomechanical factors predict total lower extremity initial energy absorption during landing. 2012 National Athletic Trainers' Association Annual Meeting and Clinical Symposium, St. Louis, MO. *Journal of Athletic Training* 47(3), S82.

Norcross MF, Lewek MD, Padua DA, Shultz SJ, Weinhold PS, Blackburn JT. (In Press). Lower extremity energy absorption and biomechanics during landing. Part I: Sagittal plane energy analyses. *Journal of Athletic Training*.

Norcross MF, Lewek MD, Padua DA, Shultz SJ, Weinhold PS, Blackburn JT. (In Press). Lower extremity energy absorption and biomechanics during landing. Part II: Frontal plane energy analyses and inter-planar relationships. *Journal of Athletic Training*.

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Primary Investigator

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Marc Norcross received his doctorate in Human Movement Science (Biomechanics concentration) at the University of North Carolina at Chapel Hill in 2011 and is currently an Assistant Professor in the College of Public Health and Human Sciences at Oregon State University. He earned his undergraduate degree in Athletic Training from Boston University in 2001, and completed a Master's degree in Exercise and Sport Science (Athletic Training Specialization) from UNC-Chapel Hill in 2003. He then worked clinically as an Assistant Athletic Trainer at UCLA from 2003-2007. His current research interests are to inform ACL injury prevention and rehabilitation programs by elucidating modifiable factors predictive of high risk landing strategies and to improve high school coaches' implementation of injury prevention programs.

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