COUPLED BIOMECHANICAL-EPIDEMIOLOGICAL STUDIES FOR THE ASSESSMENT OF ACL INJURY RISK

[1, 2] Timothy E. Hewett, [1]Gregory D. Myer and [1]Kevin R. Ford
[1]Cincinnati Children's Hospital Sports Medicine Biodynamics Center
[2] University of Cincinnati College of Medicine; email: tim.hewett@cchmc.org, web: www.cincinnatichildrens.org/sportsmed

INTRODUCTION

The goal of applied biomechanical and epidemiological research aimed at decreasing injuries in general and specifically anterior cruciate ligament (ACL) injuries in athletes must be to first determine the factors that make athletes susceptible to ACL injuries, second to develop screening tools to identify these factors in individual athletes and third to develop treatment modalities targeted to these factors in an attempt to prevent of these injuries. If preventive modalities such as dynamic neuromuscular training can reduce the incidence of knee injury by even a few percentage points, thousands of knee injuries can be prevented in high school and collegiate sports annually. In addition, with the ever increasing popularity of high-risk jumping and pivoting sports like soccer, volleyball, and basketball and the rapidly growing number of participants each year, even higher numbers of ACL and other injuries might be avoided in the future.

Neuromuscular control deficits that can be identified using kinematic and kinetic techniques may be responsible for decreased knee joint control and increased injury risk in female athletes.[1] Neuromuscular training may alter active knee joint control, decreasing ACL injury rates by correcting identified neuromuscular deficits.[2] Coupled biomechanical and epidemiologic techniques have shown the effects of growth and development on neuromuscular control deficits and on ACL injury risk and the effects of neuromuscular training on both dynamic knee control and ACL injury risk in young female athletes.[2,3,4] Coupled biomechanical and epidemiologic studies clearly demonstrate the ability not only to detect but to correct neuromuscular imbalances using biomechanical techniques. These biomechanical and epidemiologic studies provide strong evidence that biomechanical screening, computer modeling and neuromuscular training used in combination may provide an effective solution to the problem of gender inequity in knee and ACL injury.

The goal of these studies is to determine whether measured neuromuscular control deficits can predict ACL injury risk. A large-scale prospective coupled 3D biomechanical and epidemiological cohort study design was employed to determine whether prescreened athletes with decreased neuromuscular control and increased valgus joint loading had increased risk of ACL injury. [3] Prior to their competitive season, 205 female athletes in the high-risk sports of soccer, basketball, and volleyball were prospectively measured for neuromuscular control during landing using 3D kinematics and kinetics.

Nine athletes who subsequently during the following sports seasons suffered confirmed ACL ruptures had significantly different knee kinematics and kinetics than the 196 female athletes who did not go on to ACL rupture. The knee abduction valgus angle at landing was 8º greater in ACL-injured than uninjured athletes. ACL-injured athletes had a

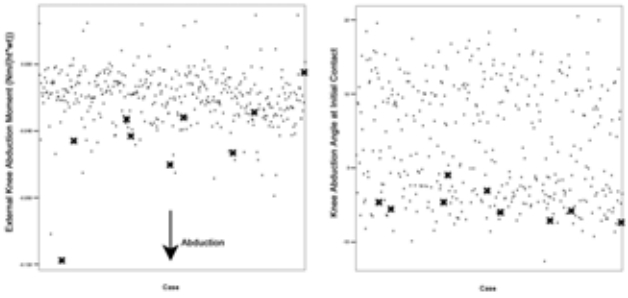

Figure 1: Knee abduction moment and knee abduction angle prospectively measured in subsequently ACL Injured (**X**) and Non-Injured Subjects.

2.5-times greater knee abduction moment and 20% higher ground reaction force. The knee abduction moment predicted ACL injury status with 73% specificity and 78% sensitivity.

CONCLUSIONS

Biomechanical and epidemiological findings demonstrate that decreased neuromuscular control, as evidenced by measures of knee abduction torque and knee abduction angle, can predict increased ACL injury risk in a high percentage of individuals.[3] Computer models show that valgus increases ACL loads.[5] A combination of computer modeling coupled with the above approach may provide the necessary answers to this problem. However, the question is whether it is possible to accurately and identify those individuals who display these potential causal factors. Effective screening programs need to be developed and put into practice that will enable identification of athletes at risk for ACL injury in order to channel them into custom-designed neuromuscular interventions.

REFERENCES

1. Hewett TE, Myer GD, Ford KR. Decrease in neuromuscular control about the knee with maturation in female athletes. *J Bone Joint Surg Am.* 2004;86-A(8):1601-1608.
2. Hewett TE, Myer GD, Ford KR, et al. Biomechanical Measures of Neuromuscular Control and Valgus Loading of the Knee Predict Anterior Cruciate Ligament Injury Risk in Female Athletes. *Am J Sports Med*. Feb 8 2005;33(4):492-501.
3. Hewett TE, Lindenfeld TN, Riccobene JV et al. The effect of neuromuscular training on the incidence of knee injury in female athletes. A prospective study. *Am J Sports Med.* Nov-Dec 1999;27(6):699-706.
4. McLean, S. G., Huang, X., Su, A., et al.: Sagittal plane biomechanics cannot injure the ACL during sidestep cutting. *Clin Biomech 19:* 828-838. 2004

ACKNOWLEDGEMENTS

The authors would like to acknowledge funding support from National Institutes of Health Grant R01-AR049735-01A1 (TEH). The authors would like to acknowledge the invaluable assistance of Scott McLean and Ton van den Bogert