Injury Rate Ratio and Knee Load Threshold Related to Increased Risk of Knee injury

Myer GD[1,2,3], Ford KR[1,2], Chaudhari AM[3], Hewett TE[1,2,3]

1. Cincinnati Children's Hospital Medical Center, Division of Sports Medicine
2. Department of Pediatrics, College of Medicine, University of Cincinnati
3. Sports Medicine, The Ohio State University

Introduction to the Problem

Introduction to the Problem: Patellofemoral dysfunction and resultant pain symptoms (PFP) and Anterior Cruciate Ligament (ACL) injuries are major concerns in the young athlete that lead to potential long-term consequences for health and physical activity. Young women experience both PFP and ACL injury 2-10 times more often than males. Decreased motor control during physical activities results in excessive knee abduction moment load that may increase risk of acute ACL injury and chronic PFP in females. The Objective of the current proposal was To determine the load thresholds that are associated with increased risk of ACL or PFP injury by comparison of injury incidence rates to knee abduction moment (KAM) during landing.

METHODS

KAM was assessed in middle and high school female basketball, volleyball, and soccer athletes prior to their competitive seasons and subsequent injuries were recorded through the season (n=145 for PFP, n=205 for ACL). Logistic regression analyses determined KAM threshold scores that provided the maximal sensitivity and specificity for prediction of PFP and ACL injury risk.

RESULTS

The cumulative incidence rate for new PFP was 2.2x greater (95% CI 1.11 to 4.34) relative to ACL injury when normalized per 100 athlete seasons (PFP 9.7 vs. ACL 4.4). Regression analysis indicated that ACL injury risk increased when athletes landed with KAM>25.3 Nm (Figure 1) and demonstrated a maximum sensitivity at 89% and maximum specificity at 73% for prediction of ACL injured status. PFP risk increased in athletes who landed from a jump with KAM>15.4 Nm and provided maximum sensitivity 71% and maximum specificity at 52% for prediction outcome.

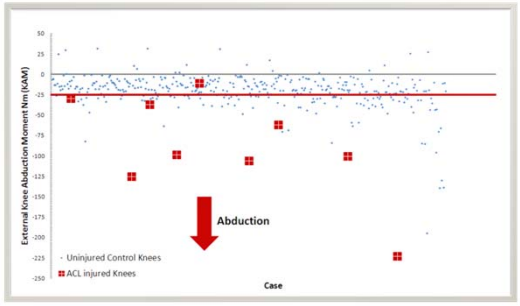

Figure 1. Prospective knee abduction moment (KAM) data from ACL injured and uninjured that was used to define KAM cut-score with maximal sensitivity and specificity.

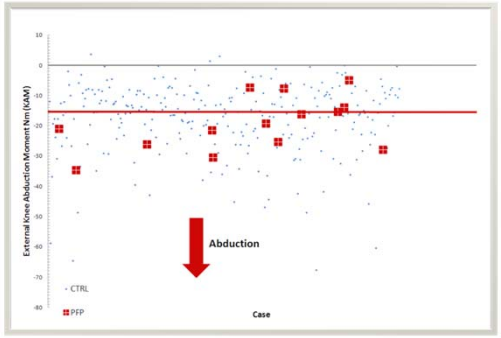

Figure 2. Prospective knee abduction moment (KAM) data from PFP injured and uninjured that was used to define KAM cut-score with maximal sensitivity and specificity.

Discussion

PFP symptoms cause up to three-quarters of these patients to limit their recreational activities or leads to cessation of physical activity altogether. Injuries to the ACL demonstrate decreased prevalence; however ACL injuries result in the greatest time lost from sport and recreational participation by young athlete. The current results indicate that females who demonstrate KAM>15.4 Nm may be at increased risk for development of PFP and those with KAM>25.3 Nm may be at increased risk for both PFP and ACL injury. An important step for prevention of ACL and PFP injury is the appropriate risk estimation for population at risk. The current results support this step in the progression through determination of threshold limits for injury risk factors. Accordingly, clinic based screening tools may be developed that are specific to PFP (Figure 3) and ACL (Figure 4) injury risk to delineate those most at risk in order to apply appropriate interventions to reduce risk.

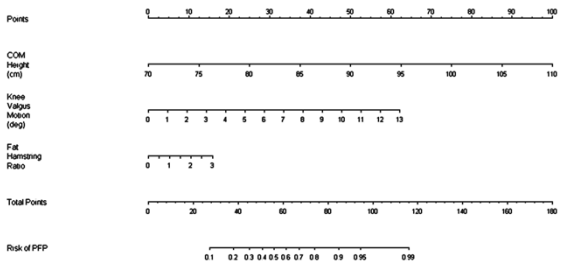

Figure 3. Clinician Friendly nomogram to predict high KAM related to increased risk of PFP

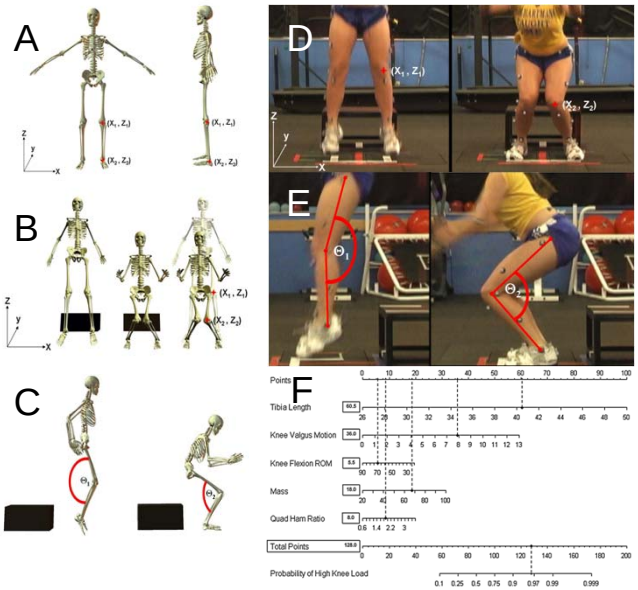

Figure 4. A. Tibia length is calculated as the distance between knee joint center and ankle joint center (Z2- Z1). B. Knee valgus motion during the drop vertical jump is calculated (X2- X1). C. Knee flexion ROM during the drop vertical jump is calculated (Θ1-Θ2). D. Videographic depiction of knee valgus motion during the drop vertical jump E. Videographic depiction of knee flexion ROM during the drop vertical jump. F. Completed nomogram for the representative subject (Tibia length: 40.5 cm; Knee valgus motion: 7.8 cm; Knee flexion ROM: 69.8°; mass: 67.5 kg; QuadHam: 1.90). Based on her demonstrated measurements this subject would have a 95% (128 points) percent chance to demonstrate high KAM during the drop vertical jump. Her actual KAM measure for the presented drop vertical jump that was quantified simultaneously with 3D motion analysis was 44.1 Nm of knee abduction load.

Conclusion

The increased incidence of PFP relative to ACL injury is likely associated with the reduced threshold of KAM associated with increased injury risk. Development of clinic/field based screening tools to identify female athletes who land from a jump with excessive KAM that places them at risk for knee injury may facilitate the application of targeted exercise intervention to reduce injury risk. Focused pre-season neuromuscular training may be warranted for females who land with KAM>15 Nm, while those females who land with KAM>25 Nm may benefit from increased treatment dosage gained from both pre-season and in-season interventions.

References

1. Myer GD, Ford KR, Khoury J, Succop P, Hewett TE. Development and validation of a clinic-based prediction tool to identify female athletes at high risk for anterior cruciate ligament injury. Am J Sports Med. Oct 2010;38(10):2025-2033.
2. Myer GD, Ford KR, Barber Foss KD, Goodman A, Ceasar A, Rauh MJ, Divine JG, Hewett TE. The incidence and potential pathomechanics of patellofemoral pain in female athletes. Clin Biomech (Bristol, Avon). Aug 2010;25(7):700-707.
3. Hewett TE, Myer GD, Ford KR, Heidt RS, Jr., Colosimo AJ, McLean SG, van den Bogert AJ, Paterno MV, Succop P. Biomechanical Measures of Neuromuscular Control and Valgus Loading of the Knee Predict Anterior Cruciate Ligament Injury Risk in Female Athletes: A Prospective Study. Am J Sports Med. Feb 8 2005;33(4):492-501.

The authors acknowledge funding support from NIH/NIAMS Grants R01-AR049735, R01-AR05563 and R01-AR056259.

Contact: greg.myer@cchmc.org