Effect of Foot Rigidity on Tibial Rotation, Rate of Loading, and Landing Mechanics in an Active Population

Keene KA, Cattano NM, Morrison KE, Stearne DJ: West Chester University of Pennsylvania, West Chester, PA

Context: Anterior cruciate ligament (ACL) injuries are a common and debilitating injury among an athletic population. Previous research would suggest that arch stiffness may alter tibial rotation, rate of loading, and landing mechanics, possibly increasing ACL injury risk during landing and deceleration tasks. ACL injuries are multifactorial in nature. However, the relationship of arch stiffness on these lower extremity kinetics and kinematics in regards to ACL injury is currently unknown. Objective: To determine the tibial rotation, landings mechanics, and rate of loading differences based on arch stiffness categorization (i.e. rigid vs. supple) in a physically active population while performing a stop jump landing task. Design: A two-group cross-sectional design Setting: Biomechanics research laboratory.

Participants: A physically active convenience sample from a college aged student population was used for this study (n = 27; mean age = 20±1.09 years, mean height = 172.71±9.48 cm; mean weight = 71.89±11.07 kgs; male = 12, mean age = 19.83±0.90 years, mean height = 179.57±4.56 cm; mean weight = 80.74±7.42 kgs; female = 15; mean age = 20.13±1.20 years, mean height = 167.22±8.79 cm; mean weight = 64.81±7.97 kgs). Interventions: Independent variable of interest included arch stiffness values. Arch stiffness was calculated in the dominant foot by utilizing arch height index (a previously found valid and reliable measure, ICC values above 0.939 for intrater reliability and 0.811 for interter reliability; above 0.844 validity), a measure of dorsal height normalized to foot length. Groups were defined using arch stiffness values separating participants into a rigid arch and supple arch group. Inclusion into the rigid arch group required a value ≥ 1,850 and the supple arch group value required an arch stiffness value ≤ 1,250. Main outcome measures: Dependent variables of interest included the Landing Error Scoring System (LESS) (a previously found reliable and valid measure; \( \kappa = 0.459–0.875, \text{ICC} 2.1 = 0.835, P < .001 \)), degrees of tibial rotation, and rate of loading. Results: Independent t-tests were used to assess differences in tibial rotation, rate of loading, and LESS scores in differing arch stiffness groups. Statistical significance was found when comparing arch stiffness with rate of loading (rigid rate of loading mean = 54.23±55.16, and supple rate of loading mean = 23.80±15.61, t= 1.864, p = 0.043). The rigid arch group had a significantly higher rate of loading than the supple arch group. Conclusion: Our results showed that there were significant differences among rigid and supple arch stiffness groups in rate of loading. No other significance was found. We suggest that having a rigid arch stiffness value may contribute to increased rate of loading, possible increasing potential force placed on the ACL. Word count: 435