The Effects of Fatigue on Single Leg Landing Mechanics

Abstract

Background

Faulty positional mechanics at the knee during single limb landing have been associated with non-contact soft tissue injury[1]. In particular, landing with increased knee extension and knee valgus have been associated with increased risk of ACL injury. Athletes perform single limb landings during sport in both fatigued and non-fatigued states. Current literature sites conflicting evidence regarding the effect of fatigue on positional mechanics at the knee during these tasks. While some studies have identified increased knee valgus and extension post-fatigue[2 3 4], others have found no correlation between fatigue and positional risk factors[5]. With the current discrepancy in the literature, further study is necessary to investigate the relationship between fatigue and lower extremity mechanics during single limb landing. This study examines single limb landing mechanics at the knee before and after an established fatigue protocol[6 7].

Methods

Baseline height, weight, leg length, and ankle/knee girth were assessed in two subjects, one adult male and one adult female. The subjects were recorded performing three maximum vertical double leg hops to single leg landings using skin-mounted markers and an 8-camera 3D motion capture (Vicon). This data was recorded both before and immediately following an established fatigue protocol. The fatigue protocol consisted of 5 jump squats and a 15 meter run, repeated until the subjects reached a rating of perceived exertion (RPE) of 17/20. Angular displacement of the knee was recorded in the frontal and sagittal planes upon landing.

Results

The researchers found that the fatigue protocol did not increase positional risk factors at the knee during single limb landing. Relative to data from pre-fatigue trials, no change, or slight increase in knee flexion angles was observed during post-fatigue trials. These results suggest more optimal knee mechanics following a fatigue protocol.

Conclusions/Discussion

Fatigue conditions resulted in a reduced knee valgus angle and slightly increased knee flexion angle during single-limb landing in the two subjects. Warming up before exercising has shown to decrease injury insticances[8]. The fatigue protocol may have acted as a dynamic neuromuscular warm-up for the subjects in this study. Further studies involving more subjects and analytics are indicated to establish the effect of fatigue on knee mechanics during single-limb landing.

Works Cited

1. Voskanian, N. ACL injury prevention in female athletes: review of the literature and practical considerations in implementing an ACL prevention program. Curr Rev Musculoskelet Med. 2013;6:158–163.
2. Lucci C, Cortes N, Van Lunen B, et al. Knee kinematics is altered post-fatigue while performing a crossover test. J Sci Med Sport. 2011;14:453-459.
3. Pollard C, Sigward S, Powers C. Limited hip and knee flexion during landing is associated with increased frontal plane knee motion and moments. Clin Biomech. 2010;25:142.
4. Thomas AC, McLean SG, Palmieri-Smith RM. Quadriceps and hamstrings fatigue alters hip and knee mechanics. J Appl Biomech. 2010;26:159-170.
5. Patrek M, Kernozek T, Willson J, et al. Hip-abductor fatigue and single-leg landing mechanics in women athletes. J Athl Train. 2011;46:31-42.
6. Moran K, Marshall B. Effect of fatigue on tibial impact accelerations and knee kinematics in drop jumps. Med Sci Sports Exerc. 2006;38:1836-1842.
7. Xia R, Zhang X, Wang X, et al. Effects of two fatigue protocols on impact forces and lower extremity kinematics during drop landings: implications for noncontact anterior cruciate ligament injury. J Healthc Eng. 2017;epub.
8. Arundale A, Bizzini M, Giordano A, et al. Exercise-based knee and anterior cruciate ligament injury prevention. J Orthop Sport Phys Ther. 2018;48:A1-A42.
9. Liederbach M, Kremenic IJ, Orishimo KF, et al. Comparison of landing biomechanics between male and female dancers and athletes, part 2: Influence of fatigue and implications for anterior cruciate ligament injury. Am J Sports Med. 2014;42:1089-1095.
10. Lepley L, Thomas A, McLean S, Palmieri-Smith R. Anterior cruciate ligament-reconstructed patients. J Sport Rehabil. 2014;22:83-92.
11. Melick NV, Cingel, REHV, Brooijmans F, et al. Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. Br J Sports Med. 2015;50:1-13.