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Identification of Kinematic and Kinetic Injury Risk Predictors in Division I Football Athletes

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Introduction

Extensive research has been performed to identify biomechanical patterns and insufficiencies that may influence risk of ligamentous injury, such as an anterior cruciate ligament (ACL) tear. One kinematic pattern that has been identified as detrimental to ACL integrity is frontal plane knee collapse (valgus) during jumping and landing tasks.[1] Inter-limb differences in force generation have also been connected to the occurrence of lower extremity injury.[2] It is not known, however, whether these patterns contribute to the occurrence of lower extremity (LE) non-contact soft-tissue injury. The counter-movement vertical jump (CMVJ) is one way to simultaneously screen for knee collapse and asymmetrical force production patterns. This method was therefore utilized.

Research Methods

A retrospective cohort study was performed. During pre-season training, 12 collegiate football athletes performed a baseline CMVJ for maximum height as part of their performance testing protocol. Bilateral lower extremity kinematics and forces were recorded during the test (Fig. 1 and Fig. 2). Using two-dimensional kinematic data in the frontal plane, the minimum knee separation distance prior to lift-off was determined for each athlete and normalized by their hip width (nKSD). Concurrently, peak vertical ground reaction force was measured for each lower limb using two floor-mounted force plates. These values were normalized to the athlete's mass. Over the following five months after testing, lower extremity, non-contact, soft-tissue injuries were tracked and recorded. The athletes' data were then sorted into injured and non-injured groups based on the occurrence of lower extremity, non-contact, soft-tissue injury that resulted in lost practice or game participation. The nKSD and inter-limb differences in force generation of these two groups were then compared using independent t-tests and effect sizes (ES).

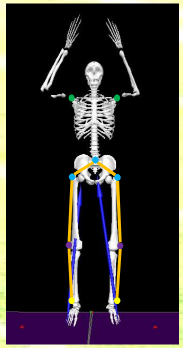

Figure 1: Frontal view of a skeleton generated from the subject's data using 3D motion analysis software. This was the starting position for all CMVJ tests.

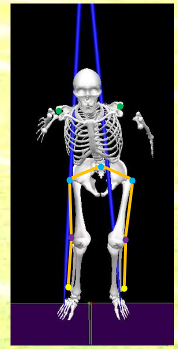

Figure 2: Frontal view of the computer-generated skeleton in the counter-movement phase of the CMVJ test. Knee valgus is apparent at this phase.

Results

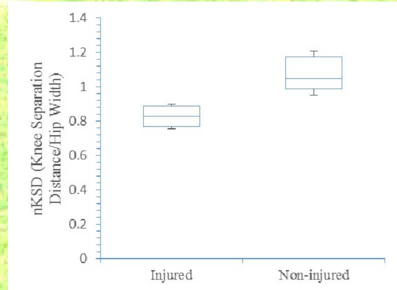

Figure 3: Box plots of nKSD data collected on both injured (n=6) and non-injured (n=6) groups.

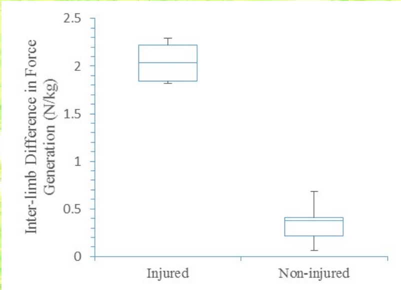

Figure 4: Inter-limb force generation differences in both injured (n=6) and non-injured (n=6) groups.

Over the observation period, 6 of the athletes reported at least one LE non-contact soft tissue injury that required them to cease participation in practices or games. Specifically, these injuries were inflicted on the adductor region (5), hamstrings (2), and hip flexors (2). 3 athletes suffered injuries to two of the previously described structures. In most cases (4), the force dominant limb sustained injury.

The injured group possessed a significantly smaller nKSD (0.83 ± 0.07, range 0.75–0.90 *vs* 1.07 ± 0.11, range 0.95–1.21, $p=0.001$, ES 2.60; Fig. 2 and Fig. 3) and significantly larger inter-limb difference in force generation (2.04 ± 0.22 N/kg, range 1.82–2.30 N/kg *vs* 0.35 ± 0.21 N/kg, range 0.07–0.68 N/kg, $p<0.0001$, ES 7.84; Fig. 4) when compared to the non-injured group.

Discussion/Conclusion

LE mechanics (nKSD and inter-limb force generation difference) measured prior to injury occurrence were different between football athletes who sustained injury compared to their non-injured counterparts, as noted by the large effect sizes. Athletes who suffered injury to the soft tissues of the LE also exhibited mechanics that are known to be injurious to the structures of the medial compartment of the knee joint (i.e. ACL). In those cases, detection of such mechanical insufficiencies have enhanced preventative mechanisms aimed towards reducing the risk of ACL injuries. The results of this study show promise for a similar relationship between the described biomechanical patterns and occurrence of LE non-contact soft-tissue injuries, and therefore promise for potential preventative mechanisms as well. Since this initial research targeted a small sample size, future work should further investigate the relationship between these insufficiencies and the eventual occurrence of LE non-contact soft-tissue injuries. In addition, further research should examine the correlation between nKSD, inter-limb force generation differences, and non-contact soft-tissue injury across a larger sample of American football athletes, as well as determine the strength of correlation within position groups and other sport populations.

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