Testing ACLR football players on the field: an algorithm to assess cutting biomechanics injury risk through wearables

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Summary

The aim of the present study was to provide a practical tool to assess the ACL injury risk during the RTS continuum through sport-specific biomechanical testing. 62 (21 ACLR, 40 healthy controls) performed planned and unplanned football-specific changes of direction in a football pitch. Kinematics was collected through 8 wearable inertial sensors (MTw Awinda, Movella). An algorithm to determine the risk of knee loading based on the dangerous movement patterns was provided ("*Anterior Cruciate Ligament Injury Risk profile Detection*", ACL-IRD). The ACL-IRD algorithm detected at-risk biomechanics in about one-fourth of the trials, mostly when performed with the injured limb. A graphical interface with an automatic report for clinicians was provided. The ACL-IRD algorithm objectively detects injury risk biomechanics in ACLR football players during on-field testing based on wearable inertial sensors and has the potential to assist the RTS decision making through ecologically valid, data-driven assessments of ACLR players.

Introduction

Recent studies identified clear injury risk patterns associated with anterior cruciate ligament (ACL) injury in football (soccer), occurring during pressing and deceiving actions [1]. Football-specific cutting movements evaluated on-field are crucial to detecting dangerous biomechanics but challenging to incorporate in clinical practice [2]. The study aimed to provide a practical tool to assess the ACL injury risk during RTS continuum through biomechanical testing. The tool adopts a dedicated algorithm named "*Anterior Cruciate Ligament Injury Risk profile Detection*" (ACL-IRD). It was hypothesized the ACL-IRD algorithm would detect risk factors for ACL injury even after clearance for RTS in ACLR players.

Methods

Sixty-one football players (40 healthy, 21 ACLR, mean age 16.2 ± 2.2 years) were enrolled. The ACLR players were cleared for RTS (>14 months after ACL surgery). Data collection was held in a regular football pitch. The players performed pre-planned and unplanned changes of direction to simulate football-specific defensive pressing (FS deceiving action). Joint kinematics was collected through eight wearable inertial sensors (MTw Awinda, Movella) placed on the lower body and trunk through a validated workflow. The ACL-IRD algorithm was designed to simultaneously evaluate multiple biomechanical risk factors based on quantitative thresholds belonging to three categories: knee valgus collapse, sagittal knee loading, and trunk-pelvis imbalance [3]. The thresholds were adapted from healthy control players' biomechanics. A graphical interface with an automatic report for clinicians was provided.

Results and Discussion

The ACL-IRD algorithm detected at-risk biomechanics in 36-37/104 trials in Agility t-test and 25-41/97 trials in FS deceiving action, respectively at initial contact and peak knee flexion. Over 60% of the at-risk trials were performed with the injured limb. Risk factors such as knee/hip flexion ratio, knee valgus, and hip abduction frequently emerged regardless of the movement task. The detailed description of the report for an example case was provided.

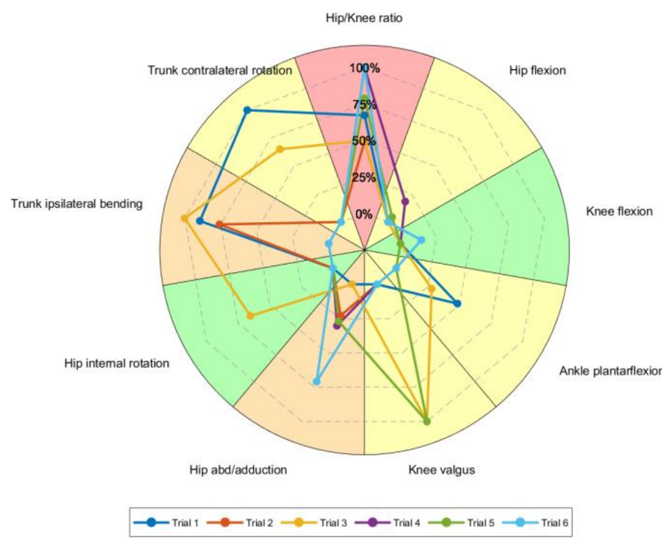

Figure 1: Risk factors visualization identifying the number of factors identified as patterns associated with ACL injuries.

Conclusions

The ACL-IRD algorithm is the first clinical-friendly, data-driven tool to assess the ACL injury risk on the field in testing ACLR football players during RTS continuum. The algorithm was able to detect biomechanical risk profiles related to the occurrence of non-contact ACL injury in young ACLR players even after clearance for RTS.

References

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[2] Gokeler et al (2022). *J Exp Orthop*, **9(111)**.
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