Differences in Kinematic and Muscle Activity Associated with ACL Injury Risk in Second Division Female Football Players: Influence of Direction Task.

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Resumen

This study aims to analyze key knee kinematic variables and lower-limb muscle activity to identify differences in motor control and movement quality related to the anterior cruciate ligament (ACL) injury mechanism. The findings may identificate at-risk players and improve prevention strategies by assessing functional movement patterns during dynamic tasks.

Background

Given the combined impact of the ACL incidence and its burdensome, and the persistent sex-related prevalence disparities, improving evaluation strategies in female players remains essential[1,2]. Incorporating new kinematic variables, such as angular velocity, which is more closely linked to motor control, alongside traditional joint angle measurements could enhance assessment specificity [3–5]. By focusing on key muscles such as hamstrings and quadriceps and considering secondary muscles like gastrocnemius to analyses functionality, may help distinguish motor patterns between players at risk of ACL injury and healthy players[6–8]. Therefore, this study aims to evaluate knee kinematics and lower-limb muscle activity in players at risk of ACL injury compared to healthy players during three side-cutting tests. It also investigates how the amplitude of direction change influences stabilization parameters.

Methods

A cross-sectional study was conducted with 16 participants (23.4 ± 5.03 years), divided into Injured and Healthy groups. Injured players had a history of non-contact knee injury involving valgus collapse, without undergoing surgical intervention. Three change of direction tests (CODAT, GOB, and Turn) were used for evaluation, (Figure 1). The peak and range of knee joint angles and angular velocities across three planes, along with the average rectified and peak envelope EMG signals of the Biceps Femoris (BF), Semitendinosus (ST), Vastus Medialis (VM), and Gastrocnemius Lateralis (GL), were recorded during the preparation and load phases. Group differences were analyzed using two-factor mixed-model ANOVA with pairwise comparisons. Statistical significance was set at $p < 0.05$.

Results

Injured players demonstrated lower external tibial rotation angular velocity and a greater range of motion in tibial external rotation compared to Healthy players. Additionally, the Injured group showed significantly higher average rectified muscle activity in the Vastus Medialis (VM) and Gastrocnemius Lateralis (GL), with both increased by 4% during the load phase. The CODAT and TURN tests elicited higher average rectified muscle activity in the Biceps Femoris (BF) and VM, as well as higher peak envelope activity in the VM, compared to the GOB test. The TURN test also showed greater extension angular velocity in the sagittal plane.

Conclusion

The results revealed differences in knee kinematics and muscle activity between players with a previous ACL injury and healthy players, influenced by the amplitude of directional changes.

Clinical implications

This study highlights the importance of assessing kinematics in conjunction with specific muscle activity during functional tests that replicate ACL injury mechanisms, in order to better determine player risk profiles and design more effective prevention programs.

Key words

Anterior cruciate ligament, biomechanics, electromyography, female football, injury prevention

FIGURES

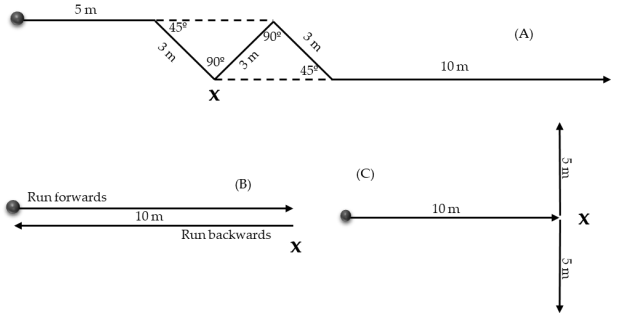

Figure 1. Functional change of direction test: CODAT test, GOB test and TURN test. The initial point of the test is drawn with a ball and the cross identifies the change of direction task that was recorded. (A) Change of Direction and Acceleration Test (CODAT), this test combines sprinting mechanics with the stabilization and acceleration required for change of direction movements. It consists of four diagonal change of direction tasks: two at 45° and two at 90°, interspersed with 3-meter sprints and culminating in a 10-meter sprint. (B) Go and Back test (GOB), this test involves a 10 m frontal sprint at maximum possible speed, followed by deceleration and a final backward sprint. It simultaneously incorporates a change of direction and a deceleration task, both of which are common mechanisms associated with ACL injuries. (C) TURN test, this test is a modified version of the T-test. It involves a frontal sprint followed by a single pre-planned 90º change of direction, performed once in each direction.

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