Does Type of Unanticipated Stimulus Alter Knee Mechanics During Dynamic Tasks?

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Summary

Noncontact ACL injuries occur during dynamic movements, and females are more than twice as likely to have an ACL injury compared to males. Decision-making tasks have shown altered knee mechanics and may better represent game-like scenarios in the lab. However, it is unknown if the unanticipated stimuli commonly used replicate real-life scenarios. Eight females and eight males completed sidecutting tasks with a visual stimulus and a human defensive opponent stimulus. Sagittal plane knee loading increased with the defender compared to the visual stimulus for males and females, while the visual stimulus increased frontal plane loading for females.

Introduction

Noncontact anterior cruciate ligament (ACL) injuries occur during movements that involve sudden decelerations and directional changes due to combined sagittal and frontal plane knee loading [1]. Additionally, females are more than 2 times likely to have an ACL injury compared to males [2]. Previous studies have shown altered knee mechanics when decision-making to an external stimulus (i.e. visual light) is involved [3]. Including these decision-making tasks may better represent game-like scenarios compared to anticipated tasks. Currently, it is unknown how a live, human defensive opponent affects knee biomechanics during sidecutting tasks. The purpose of this study was to identify differences in knee biomechanics during sidestep cutting in response to a visual stimulus and a live, human defensive opponent.

Methods

Eight females (age: 22.5±3.0yrs; height: 1.70±0.07m, mass: 69.11±11.16kg) and eight males (age: 23.9±3.0yrs; height: 1.79±0.05m, mass: 85.83±6.64kg), all recreationally active, completed two unanticipated 45° cutting conditions (visual stimulus (VS); human defensive opponent (DO)). Approach speeds ranged from 3.75m/s–4.25m/s. For the VS condition, a custom LabVIEW program presented one of three tasks: a cut to the left, a cut to the right, or a stop visual stimulus in a randomized order. This stimulus was triggered after participants crossed a timing gate that was 1.75m away from the force plate. For the DO condition, the same three tasks were used in a randomized order. A research assistant (defender), standing in the same location as the visual stimulus monitor, attempted to "block" the participant's running path by performing a defensive move when participants passed the trigger timing gate, giving the same reaction time range as the VS condition. From the time the stimulus was triggered to contacting the force plate, participants had a reaction time of 412–467ms for both conditions.

Three-dimensional (3D) marker coordinate data were collected using a 12-camera Vicon system (200Hz), and ground reaction forces were collected with two AMTI force plates (2000Hz). 3D kinematics and internal moments, normalized to body mass, of the dominant leg were calculated. Peak sagittal and frontal plane knee angles and moments were extracted for analysis. Separate 2×2 mixed-model repeated measures ANOVAs (condition × sex) were performed (α=.05).

Results and Discussion

There was a significant condition main effect for knee extension moments, which were greater in DO compared to VS (p = .009, Table 1). Significant interactions were present for peak flexion angle and adduction moment. Females had greater flexion angles (p = .001) and adduction moments (p = .030) in VS compared to DO. Additionally, males had higher adduction moments than females, solely in DO (p = .026).

Results suggest sagittal plane knee loading is greater in a more realistic setting with the defensive opponent present. Additionally, the visual stimulus increased frontal plane knee loading in females. Interestingly, knee abduction angles were not statistically different between either sex or conditions

Conclusions

While both a visual stimulus and simulated defender stimulus have been analyzed separately, no study has directly compared the two. Our results revealed differences in knee biomechanics between the two conditions. Specifically, the visual stimulus may amplify injury risk variables in females such as peak knee adduction moment. These differences between conditions may suggest that simulated defender more closely replicates the demands of a practice/game situation in the laboratory environment. Therefore, studies investigating factors possibly associated with ACL injury should account for how stimuli are presented to participants.

References

[1] Besier TF et al. (2001). *MSSE*, Vol **33**, 1176-1181.
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Table 1: Mean ± SD knee kinematic and kinetic variables between sexes and conditions.

		Defensive Opponent		Visual Stimulus	
		Female	Male	Female	Male
Peak Angles	Knee Flexion (°) §	-52.0±4.9[A]	-57.2±6.1	-60.8±5.0	-58.1±7.8
	Knee Abduction (°)	-8.4±4.5	-8.2±4.5	-10.0±6.2	-7.2±4.1
Peak Moments	Knee Extension (Nm·kg^{-1}) *	2.54±0.81	3.19±0.49	2.20±0.85	2.78±0.71
	Knee Adduction (Nm·kg^{-1}) §	0.37±0.17 [AB]	0.61±0.22	0.51±0.26	0.50±0.09

§ significant interaction, [A] significantly different from VS, [B] significantly different from males in DO, * significant task effect