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Strategies to fulfil a rapid change in direction

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Abstract

Introduction

In court sports like soccer, team handball, basketball etc., rapid changes of the direction of the movement can be success-limiting factors. Biomechanical requirement for performing rapid changes in the direction of the movement are not well understood. The movement pattern can influence the musculo-skeletal loading and modulate the injury risk. This also relates to the risk of sustaining an anterior cruciate ligament (ACL) injury [1]. This reveals, that different movement strategies exist, to perform rapid changes of the direction of the movement. These strategies might also have an influence on athletic performance. Furthermore, different movement strategies might potentially influence the functionality of footwear, or from another perspective: footwear might have different influence on athletic performance as well as on musculo-skeletal loading, if cutting movements are executed with different strategies. Therefore investigating motion strategies in rapid changes of the direction of movements might be relevant for footwear design. The purpose of this study was to identify specific movement strategies for performing 90° cutting manoeuvres.

Methods

Fifty subjects participated in the study. They performed rapid 90°-changes of the movement direction. Fourteen infrared cameras (200 Hz, VICONTM, Oxford, UK) and two FPs (1000 Hz, Kistler107 Instrumente AG, Winterthur, Switzerland) were used to for inverse dynamics and inverse kinematics calculations. They were obtained using an anatomic-landmark-scaled Lower-Body-Model [2] [3].

Results

About one third of the subjects performed the 90° cut with touching the ground with the rearfoot first. This group also showed higher knee internal rotation, knee abduction (valgus) and higher knee flexion moments compared to the other group, which performed the 90° cuts with touching the ground with the forefoot first. Furthermore, the forefoot group performed the cuttings with an about 0.1 s shorter contact time than the rearfoot group. To perform the forefoot contact, the forefoot group also had a higher sideward leaning into the anticipated new running direction as well as a stronger pre-rotation about the longitudinal axis of the total body.

Discussion
Two movement strategies were identified performing rapid 90° cutting movements. One strategy included a clear pre-orientation of the total body into the new running direction as well as a more pronounced inward leaning of the body. This strategy was coupled with a forefoot contact. The pre-orientation apparently made it possible to touch down with the forefoot first and already have the body segments ready for the acceleration in the new running direction. This leads to a reduced disadvantageous load of the knee joint, since the combination of rotation, flexion and abduction moment is reported to be a risk factor for ACL injuries. Additionally this strategy has the potential to be quicker, since the ground contact time was substantially reduced.