THE EFFECTS OF MEDIAL WEDGE FOOTWEAR ON KNEE ABDUCTION ANGLES AND POSTERIOR GROUND REACTION FORCES DURING AN UNANTICIPATED CUTTING MOVEMENT

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INTRODUCTION

Non-contact anterior cruciate ligament (ACL) injuries tend to be severe and cause athletes to miss considerable time. Female athletes are more likely to suffer a non-contact ACL injury than male athletes (1). Female athletes have also demonstrated greater maximum knee abduction angles during cutting movements, suggesting that knee abduction may play a role in the injury mechanisms (2). This difference has been attributed to increased loading of the ACL (3). It is therefore suggested that high knee abduction angles play a role in the injury mechanisms for a non-contact ACL injury. Additionally, during landing tasks, it has been reported that an increase in impact forces are a potential ACL injury-risk factor (2). More specifically, the peak anteroposterior ground reaction force (GRF) has been associated with ACL loading (4). When an athlete completes a cutting movement, if the movement is unanticipated, there is an increase in joint loading and the movement is altered compared to an anticipated movement (5). Lateral wedged footwear has been shown to alter knee dynamics during walking in both healthy (6) and knee OA patients (7), suggesting that wedged footwear can influence angles in the frontal plane. Therefore, the primary purpose of this study is to determine if medial wedge footwear could reduce peak knee abduction angle during an unanticipated cutting movement in female athletes. The secondary purpose was to examine the effect on the peak posterior GRF. It was hypothesized that as the degree of medial wedge increased, peak knee abduction angle and peak posterior GRF would be reduced.

METHODS

A total of nine healthy, female recreational athletes volunteered for the study (Age: 22.1 ± 0.4 years, Height: 1.655 ± 0.58 m, Mass: 60.4 ± 5.3 kg). Three footwear conditions were studied: two involving the use of medial wedge footwear conditions (3.5° and 5° medial wedge inserts) and a control condition without a wedge. The medial wedge conditions were created by inserting pre-cut ultra-high EVA material Podowedge inserts (A. Algeo Ltd., Liverpool, England) with wedged planes to create an elevation of 3.5° and 5°. Subjects used their own footwear for this study. A static trial was recorded for each footwear condition for each subject. Subjects were instructed to accelerate maximally towards the force platform (2000 Hz, Kistler Instrumente AG, Winterthur, Switzerland) and completed an unanticipated cutting movement at 45° to the left. The movement was made unanticipated by having subjects react to the movement of a ball to either continue to run straight or cut left using their right leg. 3D kinematics were recorded using a 10-camera motion analysis system (200 Hz, Qualisys, Inc., Gothenburg, Sweden). 3D lower limb kinematics and ground reaction forces were analyzed using Visual 3D (C-Motion, Inc.). Ground reaction forces were normalized to body weight. One-way repeated-measures analysis of variance were used to determine differences between the footwear conditions (α = 0.05).

RESULTS AND DISCUSSION

No significant differences were detected in peak knee abduction angles (p = 0.218) and peak posterior ground reaction forces (p = 0.714) between footwear conditions. However, peak knee abduction angles during the stance phase were lower in 5° wedge condition (-11.723° ± 4.643) compared to the neutral condition (-13.373° ± 5.050). There was a small-to-medium effect size (ES = 0.327). However, there was no difference observed between the 3.5° wedge condition (-13.300° ± 5.650) and the neutral
condition (ES = 0.015). For the peak posterior ground reaction forces, small effect sizes were detected for the 5° wedge and 3.5° wedge conditions compared to the neutral condition (ES = 0.217 and 0.112, respectively).

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It should be noted that the effect of the medial wedge was assessed in an isolated cutting movement with the focus on the knee joint. The potential effects that a medial wedge would have on other joints are unknown, in particular the ankle joint where there is potentially increased risk of ankle inversion injury. It is also unknown the effect on other movements of dynamic sports such as linear running and landing. Therefore, any future work in this area should include a more holistic approach to the effect of medial wedge footwear and investigate an innovative method where the medial wedge only occurs when completing a high injury-risk movement.

Previous literature has identified that peak posterior ground reaction force has been correlated with strain in the ACL (2). Much of this literature has examined ACL loading during landing tasks in the sagittal plane. This has resulted in differences occurring during initial loading, where changes in knee flexion angles at touchdown have elicited changes in ACL loading. However, the peak posterior GRF occurs later during the stance phase of a cutting movement, so changes have less application to ACL injury.

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Using a 5° medial wedge insert had some effect in reducing the peak knee abduction angle while the 3.5° wedge had a minimal effect on peak angle. However, the large standard deviations in the data suggests that effect of the insert differed for each individual. This suggest that individuals will react differently to adaptations in footwear, making a universal application difficult and highlights the importance of an individual approach for potential footwear injury prevention methods. Nevertheless, as the risk of ACL has been related to the peak knee abduction angle, the ability of the 5° medial wedge to reduce the peak knee abduction angle does suggest that it could potentially reduce the risk of a non-contact ACL injury during a cutting movement.

CONCLUSIONS
There is some potential in using wedged inserts to reduce the risk of ACL injury but future work is needed to determine if these inserts have negative effects on other sporting movements.

REFERENCES