INTRODUCTION

Various aerial movements with and without rotational spins are frequently performed in gymnastics, dance, cheerleading, tumbling, snowboarding, etc. These types of skills inevitably carry an injury risk, specifically on the lower extremities. Anterior-Posterior (A-P) translation and valgus collapse are primary injury mechanisms commonly associated with Anterior Cruciate Ligament injuries. External and internal rotational forces are injury mechanisms that are often times overlooked in biomechanical studies, yet are commonly seen in specific sport settings.

The purpose of this study was to investigate how performing aerial movements with and without rotational spins effects the risk of injuring the ACL.

METHODOLOGY

Twelve uninjured, active college females with a background in sports involving aerial landings performed three conditions of drop landings. Conditions included jumping off a 40 cm tall block and spinning 180° internally, 180° externally, and jumping forwards with no rotation. Participants performed three drop landings in each condition (nine trials total) in a counterbalanced order. Data in the first 100 milliseconds of landing were analyzed, as this is where ACL injuries typically occur.

Participants began with their dominant leg leading into the aerial rotation simulation. Participants landed with both feet placed bilaterally on force platforms (1600 Hz, AMTI) to record their ground reaction forces. Participants were allowed to move their arms as they desired in order to maintain balance upon landing.

3D kinematics of the movements were monitored via 21 retroreflective markers placed on specifically the dominant lower extremity, pelvis, shoulders, and cervicale. Data were recorded by 8 infrared cameras at 160 Hz through Vicon Nexus (Vicon Corp, Oxford, UK).

RESULTS & DISCUSSION

Peak knee flexion (p<0.001), valgus (p=0.003), and internal rotation (p<0.001) angles had significant main effects, as indicated by repeated measures ANOVA. Knee valgus and internal rotation moments did not show significant results.

Peak knee flexion angles (p<0.001) were significantly reduced in the 180° internal direction compared to the forward direction (Fig. 3). In addition, peak knee valgus (p=0.019) and internal rotation (p=0.001) angles were both significantly reduced in the 180° external direction compared to the forward direction.

Reduced peak knee flexion angles during the 180° internal direction landing are consistent with an increased risk of ACL injury. Reduced knee valgus and internal rotation angles during the 180° external direction may indicate a beneficial anticipation of the landing that reduced ACL injury risk.

![Figure 1: 3-D visual of an external rotation jump](image1.png)

![Figure 2: Multi-planar loading mechanisms of an ACL injury](image2.png)

![Figure 3: Peak knee angles with 95% confidence intervals](image3.png)

CONCLUSION

Performing an aerial movement with an internal rotation may increase an athlete’s risk of a lower extremity injury in comparison to performing a skill without a spin. Completing a spin in the internal direction reduced knee flexion angles upon landing, which may increase ACL injury risk.

It is suggested that athletes performing internal rotation aerial movements focus on landing with increased knee flexion as part of injury prevention training.

REFERENCES
