Influence of Limb Dominance and Sex on Lower Extremity Joint Loading During Cutting Movements

Michael J. S. Esposito[1,2], John W. Wannop[1,2], Darren J. Stefanyshyn[1,2]
[1]Human Performance Lab, Faculty of Kinesiology, University of Calgary, Calgary, Canada
[2]Department of Biomedical Engineering, Schulich School of Engineering, University of Calgary, Calgary, Canada
Email: michael.esposito@ucalgary.ca

Summary

This study examined the effects of limb dominance and sex on lower extremity joint loading during cutting movements. Analysis of soccer players performing 90° cuts revealed significant differences in joint moments between dominant and non-dominant legs, with the non-dominant leg showing greater moments linked to ACL injury risk, and minimal differences between males and females.

Introduction

Cutting movements are essential in soccer; however, these movements are associated with injuries to the anterior cruciate ligament (ACL) [1]. Female players are three times more likely to suffer an ACL injury compared to males [2], as well females are more likely to injure their non-dominant leg while males are more likely in injure their dominant leg [3]. The purpose of this study was to investigate the influence of limb dominance and sex on lower extremity joint loading during change of direction movements.

Methods

Twenty female (age: 22.7 ± 4.8 years, height: 1.67 ± 0.04 m, mass: 62.1 ± 9.8 kg) and twenty male (age: 25.0 ± 3.1 years, height: 1.75 ± 0.07 m, mass: 76.0 ± 9.5 kg) soccer players were recruited to participate in the study. During one testing session, participants perform seven trials of a 90° lateral cut with each leg, with lower body kinetics and kinematics being collected.

The main outcome variables were resultant joint moments of the ankle, knee and hip. Moments were normalized using a power curve [4]. This method was used as it was shown to remove all subject differences except the effect of the condition. Moment curves were analyzed using statistical non-parametric mapping (SnPM) [5], using a two-way ANOVA with one repeated measure. The within participants factor was limb dominance and between participants factor was sex, with a level of significance of 0.05.

Results and Discussion

No differences were found between male and female moments at any joint with the SnPM analysis. Differences were observed between the dominant and non-dominant legs with the SnPM analysis at every joint, and peak moments were extracted (Table 1). At the ankle, the dominant leg had a greater eversion ($p = 0.011$) and external rotation ($p < 0.001$) moment. At the knee, the dominant leg had a greater extension moment ($p < 0.001$) while the non-dominant leg had a greater adduction ($p = 0.019$) and external rotation ($p < 0.001$) moment. At the hip, the non-dominant leg had a greater extension moment ($p < 0.001$), and the dominant leg had a greater abduction moment ($p < 0.001$).

These results show greater differences between the moments of dominant and non-dominant legs of an individual, and minimal differences between males and females. The increased joint loads seen in the frontal and transverse plane of the non-dominant knee have previously been associated with increased ACL injury risk [6].

Table 1: Mean and standard deviation of joint moments of the lower extremity of the dominant and non-dominant leg. Units of all moments are power normalized. Bold values indicate a significant difference. DOM – dominant limb, NON – non-dominant limb.

Joint	DOM	NON
Ankle		
Plantarflexion	1.07 (0.14)	1.08 (0.16)
Eversion	**0.16 (0.05)**	**0.14 (0.05)**
External Rotation	**0.12 (0.04)**	**0.09 (0.04)**
Knee		
Extension	**0.81 (0.15)**	**0.71 (0.11)**
Adduction	**3.36 (1.50)**	**4.07 (1.75)**
External Rotation	**0.01 (0.006)**	**0.013 (0.006)**
Hip		
Extension	**0.34 (0.11)**	**0.40 (0.14)**
Abduction	**0.92 (0.74)**	**0.47 (0.75)**
Internal Rotation	0.08 (0.05)	0.09 (0.04)

Conclusions

This study demonstrates that limb dominance significantly affects lower extremity joint loading during cutting movements, with the non-dominant leg showing greater moments associated with increased ACL injury risk. Future work should investigate interventions to reduce these lower extremity joint loads.

Acknowledgments

This study was funded by a Natural Sciences and Engineering Research Council Doctoral award and an Eyes High Doctoral Recruitment Scholarship.

References

[1] Alentorn-Geli E et al. (2009). *KNEE SURG SPORT TR A*, **17**: 705-729.
[2] Walden M et al. (2011) *KNEE SURG SPORT TR A*, **19**: 3-10.
[3] Brophy R et al. (2010). *J BONE JOINT SURG*, **44**: 694-697.
[4] Wannop J et al (2012). *J APPL BIOMECH*, **28**: 665-676
[5] Trama R et al. (2021). *J OPEN SOURCE SOFTW*, **6**: 3159
[6] Hewett T et al. (2005). *J SPORTS MED*, **33**: 492-501