The potential impact of changes in footwear torsional stiffness on the knee

Shengwei Jia[1,2], Yu Liu[1], Zhaowei Chu[2], Peng Du[2], Fan Yang[2], Jingmin Liu[1]
[1]Division of Sports Science and Physical Education, Tsinghua University, Beijing, China
[2]Sports Science Research Center, Li Ning (China) Sports Goods Co., Ltd.,Beijing, China
Email: jsw23@mails.tsinghua.edu.cn

Summary

This study examines the impact of midfoot torsional stiffness on ACL injury risk during cutting maneuvers. While higher torsional stiffness (HTS) enhances foot stability by reducing relative forefoot-rearfoot rotation, it also leads to increased peak external rotation velocity at the knee joint. This may compromise knee control and elevate ACL injury risk. The findings highlight the need for a balance in footwear design to optimize stability while minimizing potential injury risks.

Introduction

Anterior cruciate ligament (ACL) injuries are common and serious among athletes, particularly during high-intensity movements such as rapid direction changes and cutting maneuvers. The occurrence of ACL injuries is closely associated with abnormal knee joint rotation and load distribution during these movements, especially during lateral cutting actions. Midfoot torsional stiffness may affect foot stability, which in turn influences knee joint kinematics and kinetics. Previous studies have shown that higher footwear torsional stiffness effectively reduces the relative rotation between the forefoot and rearfoot, thereby enhancing foot stability [1]. However, excessively high torsional stiffness may limit the natural movement range of the foot, leading to increased shear forces on the knee joint and potentially raising the risk of ACL injuries [2]. Therefore, investigating the specific impact of footwear torsional stiffness on ACL injury risk is crucial for optimizing athletic shoe design and reducing injury rates.

Methods

The study recruited 22 male university basketball players to perform cutting tests while wearing basketball shoes with high midfoot torsional stiffness (HTS) and low torsional stiffness (LTS). Kinematic and kinetic data of the knee joint and foot torsions were collected. A paired T-test was conducted to analyze the differences, with the significance level set at $\alpha = 0.05$.

Results and Discussion

HTS significantly restricted the torsional angle of the foot. There were no significant differences between the two shoes in knee joint range of motion and peak joint moments, but HTS showed a significantly higher peak external rotation velocity compared to LTS (Table 1). The reduction in foot torsional angle can enhance foot stability during lateral movements. [3]. Studies have found that rotational control of the knee joint is crucial for preventing ACL injuries during rapid rotation and lateral movements. Excessive external rotation velocity may lead to reduced knee joint control, thereby increasing the risk of injury [4].

Conclusions

Increasing shoe torsional stiffness can effectively enhance foot stability but may also increase ACL tension, leading to potential injury.

References

[1] Holt, M. B., Myer, G. D., & Hewett, T. E. (2020). Effect of footwear stiffness on lower extremity biomechanics and ACL injury risk during cutting maneuvers. *Journal of Biomechanics*, **103:** 109-116.
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Table 1: data of the knee joint and foot torsion.

	LTS	HTS	p-value
Foot torsion(°)	5.56±1.80	4.90±1.56	**0.021**
Knee adduction-abduction RoM(°)	9.59±4.00	8.89±2.97	0.197
Knee rotation RoM(°)	18.63±2.49	16.80±3.78	0.479
Knee peak abduction velocity(°/s)	188.34±134.79	175.39±71.91	0.518
Knee peak external rotation velocity(°/s)	289.85±70.00	331.11±75.46	**0.003**
Knee peak abduction moment(Nm/kg)	1.23±0.82	1.31±0.78	0.545
Knee peak external rotation moment(Nm/kg)	1.63±1.12	1.87±0.92	0.102