Relationship between ankle dorsiflexion and knee joint kinetics during a single-leg drop landing task considering body size.

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Summary

Single-leg drop landing (SDL) task is used to investigate lower extremity biomechanics. In vitro studies suggest that combined valgus and internal rotation moments increase ACL strain; however, no three-dimensional motion analysis has examined the relationship between ankle dorsiflexion (DF) and knee rotation during SDL. This study aimed to investigate this relationship while accounting for body size. Twenty healthy females participated, and static DF and the SDL task standardized based on tibial length were measured. The results demonstrated that the SDL task effectively accounted for body size. Furthermore, decreased static DF was associated with a reduced knee varus moment, while greater dynamic DF correlated with a decreased knee internal rotation moment. These findings suggest that increasing DF alone may not be sufficient to mitigate ACL injury risk.

Introduction

Single-leg drop landing (SDL) task is used to investigate in sports injury biomechanics, particularly in assessing injury risk and biomechanical changes before and after injury or surgery. In non-contact anterior cruciate ligament (ACL) injuries—one of the most common in sports—reduced ankle dorsiflexion (DF) has been associated with decreased knee flexion and increased valgus angle. While in vitro studies show that combined valgus and internal rotation moment increase ACL strain, no studies have examined the relationship between DF and knee rotation during SDL using three-dimensional motion analysis.

Furthermore, prior SDL studies have used varying task conditions (e.g., drop heights, landing positions), and differences in participants' body physiques may contribute to inconsistent knee joint loading and misinterpretation. This study aims to investigate the relationship between DF and knee joint motion using the SDL task considering body size.

Methods

Twenty healthy females participated in the study. Static DF (sDF) was measured during the Weight-Bearing Lunge Test (WBLT). Three-dimensional kinematics and kinetic ankle and knee data were acquired using a motion capture system during a SDL task with drop height set at tibial length and landing position at 120% of tibial length. The period from initial contact (IC) to 80 ms post-IC was analyzed.

The parameters included: (1) WBLT, (2) DF at IC, (3) peak of DF (pDF), (4) DF at peal Knee flexion moment (pKFM), (5) knee frontal plane moment at pKFM, and (6) knee horizontal plane moment at pKFM.

For statistical analysis, correlation and regression analysis were performed for knee frontal and horizontal plane moments with BMI, using the Shapiro-Wilk test for residuals. The relationship between DF and knee frontal and horizontal plane moments were analyzed with a linear mixed model (LMM). All analyses were evaluated at an alpha level of 0.05.

Results and Discussion

No significant correlations were observed between BMI and either the knee frontal and horizontal plane moments. Residual analysis confirmed the absence of systematic error.

Furthermore, in LMM analysis, significant differences were observed between WBLT and the knee frontal and horizontal plane moments, as well as between the DF_maxKFM and the knee frontal plane moment.

Decreased sDF and DF_pKFM were associated with a reduction in knee varus moment, suggesting a potential biomechanical risk factor for ACL injury. On the other hand, an increase in sDF was found to correlate with an increase in knee internal rotation moment.

Table 1: Relationship between ankle dorsiflexion angle and knee joint moments during Single-Leg Drop Landing in LMM analysis.

	knee frontal moment		knee horizontal moment	
	Estimate	**P-value**	**Estimate**	**P-value**
WBLT	**79.29**	**0.045 ***	**22.94**	**<0.01 ****
DF_IC	**4.09**	**0.90**	**-7.75**	**0.22**
pDF	**1.66**	**0.99**	**-12.59**	**0.55**
DF_pKFM	**42.73**	**0.041 ***	**0.51**	**0.90**

Conclusions

This study demonstrated that the SDL task accounted for body size, ensuring consistent knee joint loading. A decrease in DF was associated with a reduction in knee varus moments, whereas an increase in DF led to higher internal rotation moments. These findings suggest that simply increasing DF may not effectively reduce ACL injury risk, and its biomechanical implications should be carefully considered.

References

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