Forefoot versus Rearfoot Landing in Stop-Jump Tasks: Effects on Lower Limb Injury Risk Factors and Performance

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Summary

The optimal choice between forefoot and rearfoot landing techniques remains unclear, especially considering injury prevention and performance. Stop-jumps, which involve sudden deceleration, are common movements in sports and frequently associated with lower limb injuries. Therefore, this study aimed to evaluate the effect of the forefoot and rearfoot landing on biomechanical variables and performance during the stop-jumping task. Twenty-three active male subjects performed stop-jumps with both landing techniques while kinematic and kinetic data were collected using a motion capture system and force platform. Landing with forefoot showed shorter stance time, larger posterior ground reaction force (GRF) and GRF inclination angle. Landing with forefoot may decrease the risk of non-contact anterior cruciate ligament injuries and have an advantage in quick reaction time, as indicated by decreased stance time, but the risk of lateral ankle sprain may increase for the stop-jump task.

Introduction

Sudden deceleration movements such as stop-jumps are common mechanisms for lower limb injuries in sports [1]. The optimal foot-strike pattern during stop-jump landing remains controversial, particularly when considering both injury prevention and athletic performance [2]. While different landing strategies (forefoot versus rearfoot) may affect injury risk and performance metrics differently, their relative benefits and drawbacks remain unclear. This study aimed to investigate how forefoot and rearfoot landing strategies influence both biomechanical injury risk factors and performance outcomes during stop-jump tasks.

Methods

Twenty-three healthy, active male subjects (age: 26.5 ± 8.7 years; height: 1.78 ± 0.05 m; weight: 74.84 ± 10.21 kg) participated in this study. Kinematic data were collected using a thirteen-camera motion capture system (NOKOV Motion Capture System). Ground reaction forces were measured using a force platform (Kistler). The stop-jump task consisted of an approach run, bilateral landing, and maximum-effort vertical jump. Participants were instructed to execute the movement with maximum speed and jump height.

Results and Discussion

Analysis revealed distinct biomechanical patterns between landing strategies. While jump height remained similar between conditions (forefoot: 49.51 ± 9.12 cm; rearfoot: 50.07 ± 9.06 cm; $p > 0.05$), forefoot landing resulted in significantly shorter stance times (396.75 ± 100.27 ms vs. 433.48 ± 62.67 ms; $p < 0.05$). Rearfoot landing demonstrated reduced posterior ground reaction forces and smaller GRF inclination angles during the initial 14% of stance phase (Figure 2). Notably, forefoot landing exhibited increased ankle internal rotation at initial ground contact, suggesting potential implications for ankle injury risk (Figure 1).

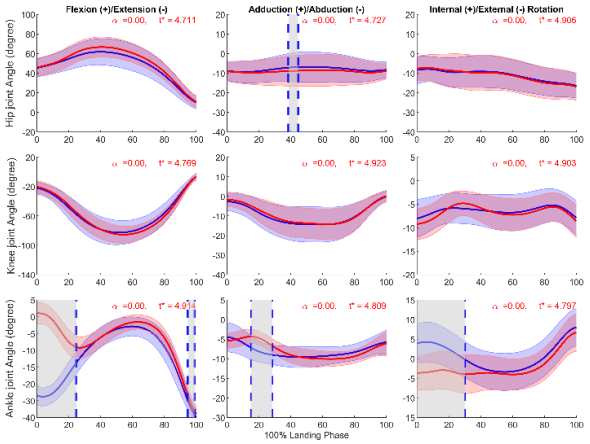

Figure 1: Mean±SD and SPM t-values of kinematic data between forefoot (blue) and rearfoot (red). Statistical differences are highlighted in grey-shaded regions, indicating $p < 0.001$.

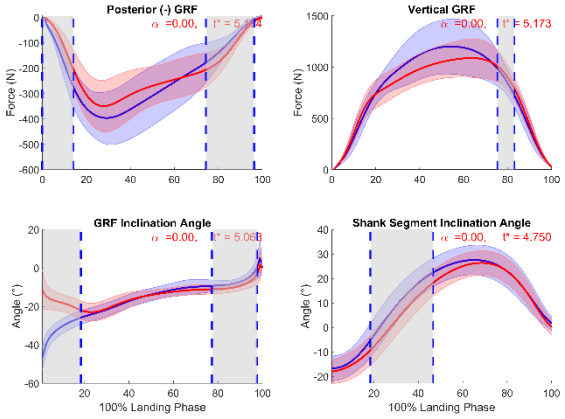

Figure 2: GRF and inclination angles with statistical differences ($p < 0.001$) highlighted, following the same legend details as Figure 1.

Conclusions

Landing with forefoot reduced stance time without compromising jump height during stop-jump tasks. While this strategy may decrease ACL injury risk, it potentially increases lateral ankle sprain risk due to greater ankle internal rotation.

References

[1] Yu B et al. (2006). *CLIN BIOMECH*, **21**: 297-305.
[2] Boden et al. (2022). *J ORTHOP RES*, **40**: 531-40.