

Effects of footwear and foot strike patterns on patellofemoral joint and Achilles tendon loading in novice runners and experienced runners

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Summary

This study treated the patellofemoral joint (PFJ) and Achilles tendon (AT) as a cohesive kinetic chain, focusing on novice runners. It comprehensively analyzed the impact of footwear (conventional and minimalist shoes) and foot strike patterns (rearfoot striking and forefoot striking) on the PFJ and AT loads in novice and experienced runners with habitual rearfoot striking. The results showed that novice runners experienced significantly higher loads on the PFJ and AT. Additionally, while forefoot striking reduced the PFJ load, it led to an increase in AT load. Therefore, novice runners were advised to gradually adapt their foot strike patterns based on the load-bearing capacity of specific joints, thereby minimizing the risk of joint-related injuries.

Introduction

Running injuries, particularly involving the PFJ and AT, are common and primarily stem from overuse. Novice runners have higher injury rates than experienced runners [1], with increased medical consultations for conditions such as patellofemoral pain syndrome and Achilles tendinopathy. Additionally, foot strike patterns and footwear choices significantly impact the loads on the PFJ and AT. Despite previous research, the interplay of forces and loading patterns within the integrated kinetic chain remains underexplored, especially for novice runners. Understanding these biomechanical differences and their impact on injury is critical for developing effective prevention strategies tailored to novice runners.

Methods

The morphology (length and cross-sectional area) of the AT in vivo was recorded by ultrasound imaging in each of the eleven male rearfoot striking novice runners and experienced runners. Subsequently, they were asked to run across a force platform at 12 km/h when wearing conventional and minimalist shoes with rearfoot striking and forefoot striking, respectively. AT and PFJ loading were estimated using kinematic and kinetic data. Three-way ANOVA was used to determine differences in PFJ and AT loading characteristics.

Results and Discussion

Patellofemoral contact force and AT impulses were significantly greater ($p < 0.05$, Figure 1) in novice runners than experienced runners, regardless of footwear or the foot strike pattern. These could be attributed to their immature running technique and posture, which resulted in excessive knee flexion and increased PFCF and ankle plantar flexion [2].

Regardless of running level, patellofemoral contact force and PFJ stress were significantly lower in forefoot striking than in rearfoot striking. In contrast, AT force, AT impulse, and peak AT stress were significantly greater ($p < 0.05$, Figure 1) in forefoot striking than in rearfoot striking. This may have been because, when forefoot striking, the runner shifted the focus of energy storage from knee flexion to the ankle, which could have decreased the load on the PFJ but increased the load on the AT [3].

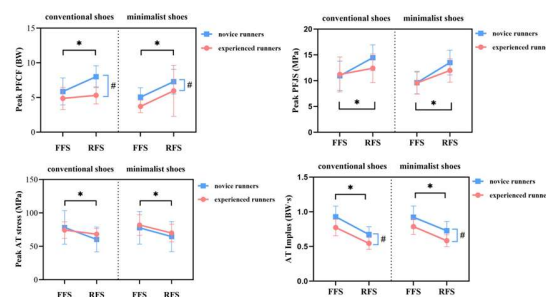


Figure 1: Effects of different running level, footwear and foot strike patterns on PFJ and AT loading. Notes: FFS, forefoot striking; RFS, rearfoot striking; * significant difference between FFS and RFS, $p < 0.05$; # significant difference between novice runners and experienced runners, $p < 0.05$.

Conclusions

Novice runners experienced a significant increase in PFJ and AT loads during running. In addition, forefoot striking increased the impulse, force, and stress on the AT and decreased the PFJS. Therefore, novice runners need to gradually adjust their foot strike pattern according to the loading capacity of different joints to reduce the corresponding injury risk.

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