Muscle Behavior Differences between Non-Rearfoot Strike Novices and Habitual Non-Rearfoot Strike Runners

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Summary

This study aimed to explore the biomechanical differences in the lower extremities and mechanics and behavior of the medial gastrocnemius (MG) between habitual rearfoot strike (RFS) runners adopting a non-rearfoot strike (NRFS) pattern and habitual NRFS runners maintaining their natural foot strike pattern during running. After transitioned to NRFS, NRFS novices had lower step frequency and leg stiffness, larger muscle fascicle and MTU shortening, and faster MTU stretch velocity, potential explaining for the deterioration in running economy after the acute transition to NRFS.

Introduction

NRFS has been shown to have several potential benefits to running economy [1], and many habitual RFS runners attempt to transition to NRFS to gain potential benefits. However, it was reported that an acute transition to NRFS running in habitual RFS runners led to a deterioration in running economy [2]. Therefore, by observing the differences in muscle behavior between habitual RFS and NRFS runners running with NRFS could reveal muscle force-generation costs and propulsive efficiency mechanisms.

Methods

15 habitual RFS runners (age: 32.27 ± 8.45 years; height: 175.15 ± 5.14 cm; mass: 67.32 ± 9.74 kg; weekly distance: 40.30 ± 19.68 km) were recruited to the NRFS novice group (NN), while the habitual NRFS group (HN) consisted of 14 runners (age: 32.27 ± 8.45 years; height: 172.71 ± 4.29 cm; mass: 69.96 ± 8.86 kg; weekly distance: 42.53 ± 20.91 km). All participants were asked to run adopted NRFS at 9 km/h, kinematics, kinetics, EMG signal, and dynamic muscle ultrasound imaging were collected.

The kinematic and kinetic data were processed by Visual 3D (version: v3.2.1), the Ultratrack (version 4.1) was used to obtain fascicle length. Based on the ground reaction force, the change in fascicle length, and the fascicle shortening length during the stance phase was calculated. The average shortening velocity of the fascicle during the stance phase was calculated as the change in fascicle length divided by the duration of the stance phase. In addition, the MTU length was calculated using the regression equations proposed by Hawkins (1990), based on the angles of the ankle and knee joints in the sagittal plane [3].

Results and Discussion

Both groups of runners met the criteria for the defined NRFS, NN group had a greater fascicle (p = 0.036) and MTU shortening (p < 0.044), and faster fascicle shortening velocities (p = 0.040). Deng (2023) found a positive correlation between foot strike angle and muscle shortening [1]. However, the NN group exhibited greater shortening despite a smaller foot strike angle, which may be attributed to their muscles not being adapted to the NRFS pattern, might not represent an energy-efficient contraction mode

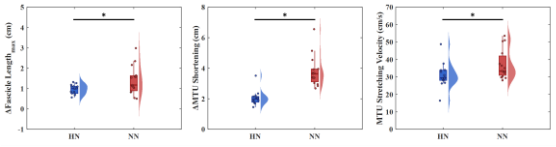

Figure 1: Differences in muscle behavior between NN and HN.

Additionally, NN group had a smaller foot strike angle (p = 0.006), lower step frequency (p = 0.017), lower vertical loading rates (average: p = 0.041; peak: p = 0.044), and lower leg stiffness (p = 0.003). No significant differences in the other variables.

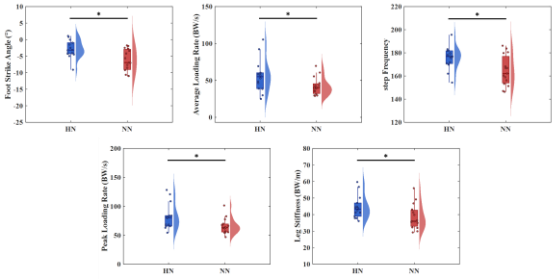

Figure 2: Differences in biomechanical variables between NN and HN.

Conclusions

Compared to habitual NRFS runners, habitual RFS runners had lower step frequency, reduced leg stiffness, larger muscle fascicle and MTU shortening, and faster MTU stretch velocity. This may potentially explain the deterioration in running economy observed after their acute transition to NRFS. Therefore, habitual RFS runners, who seeking to improve running economy through a transition to NRFS, could benefit from muscle training combined with gradual gait retraining program using minimalist shoes.

Acknowledgments

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References

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