Effect of Insoles Reducing Arch Strain on Running Comfort

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Summary

This study investigated the relationship between running comfort and arch strain when using insoles during running. Findings revealed that the medial longitudinal arch (MLA) - controlled insole, which showed the least arch strain among the four tested insoles, was associated with increased running comfort. However, no significant association was observed between the MLA-controlled and arch fit insole, which designed to match the arch shape in queit standing, suggesting that merely fitting the insole to arch shape may not effectively reduce arch strain. These results suggest that future insole selection should be based on the analysis of arch strain during running rather than on static fitting alone.

Introduction

Insoles are a tool for supporting the function of the MLA [1], which plays a critical role in shock absorption and propulsion during running. While insoles could help reduce arch strain during running, it remains unclear whether they effectively improve comfort. Furthermore, it remains unclear how arch-fitting insoles influence arch strain during running. This study aimed to determine whether running comfort differs between conditions where the MLA is controlled (i.e., low arch strain) and uncontrolled by the insole using a stretch strain sensor. Additionally, we aimed to assess the relationship between arch-fitting insoles and arch strain during running.

Methods

Fifteen healthy adults (age: 21.6 [1.7] years, height: 166.2 [5.5] cm, weight: 57.9 [6.9] kg) participated in this study. Static and overground running were conducted using the shoe default insole and three insoles with varying arch support heights condition. The MLA movement was evaluated using a stretch strain sensor, which was applied based on the spring ligament method [2]. Arch strain was calculated as the difference between the initial contact value and the maximum value during the 0–50% stance phase of running (Figure 1). Among the four insole conditions, the condition with the smallest arch strain during running was defined as the MLA-controlled condition, and the condition with the largest arch strain as the non-controlled condition. In addition, arch shape was classified into Low, Middle, and High based on footprint, and matching insoles were defined as the fit insole. Running comfort was assessed using a visual analog scale (VAS), where higher scores indicated greater comfort. Paired t-tests were used to compare running comfort between the MLA-controlled and non-controlled conditions. We used a chi-square test to examine whether the MLA-controlled condition corresponded to the arch fit condition.

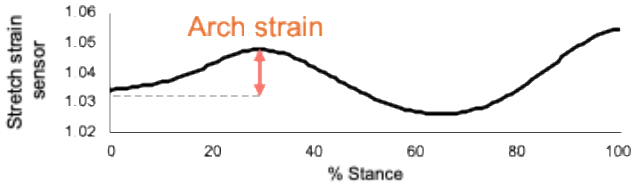

Figure 1: Signal pattern of stretch strain sensor.

Results and Discussion

Due to missing arch strain data during running, three participants were excluded. The average arch strain during running for all participants was 1.40 [1.01]. For the MLA-controlled group, the average arch strain was 0.99 [0.80]. The non-controlled group had an average strain of 1.91 [1.17]. The MLA-controlled condition showed a significantly higher VAS compared to the non-controlled condition (MLA-controlled: 32.1 [7.4] mm, non-controlled: 23.5 [9.1] mm, $p = 0.007$). The chi-square test indicated no significant association between MLA control and arch fit, with 4 "Fit" and 8 "Non-fit" participants in the MLA-control condition, and 3 "Fit" and 9 "Non-Fit" participants in the non-control condition ($p = 1.000$).

The use of a stretch strain sensor enabled us to investigate the relationship between MLA movement and comfort while preserving the structural integrity of the shoes. No significant relationship was found between the MLA-controlled and arch-fitted conditions, suggesting that insole selection should be based on the analysis of arch strain during running rather than on arch shape in static alone.

Conclusions

Insoles that reduce arch strain during the stance phase enhance running comfort. However, the lack of a significant association between the MLA-controlled and arch-fit conditions suggests that simply matching the insole to the foot shape is insufficient. Future designs should dynamically adapt to arch movements to optimize support.

Acknowledgments

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References

[1] T.G. Almonroeder et al. (2016). *J. Orthop. Sport. Phys. Ther*. **46**, 749–755.
[2] Sakamoto et al. (2021). *Gait Posture;* **86**: 180-185.