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Gradual increase of varus angle of running shoes gradually reduces pronation while maintaining cushioning properties

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Introduction

Excessive pronation is considered to be the cause of various overuse injuries. Thus, different mechanisms to control excessive pronation have been developed (e.g. dual density and medial support shoes). Reducing effects of shoes with extreme varus angles (VA) of 8–10° on pronation (TPR) and maximum pronation velocity (MPV) have been shown [1,2]. However, resultant GRFs, loading rate, peak acceleration, and transient rate were observed to be increased [2]. It was concluded that shoes with increased VA lead to reduced cushioning properties by reducing range of motion. The goal of this study was to analyze the effects of gradual 1°-changes in VA (0–4°) in running shoes on pronation and cushioning parameters. Furthermore, the capability of runners to perceive these VA changes should be tested.

Methods

Three studies were performed with a total of 28 recreational heel-to-toe runners (26.4 yrs (± 5.8), 72.0 kg (± 6.4 kg)). In laboratory study A and B subjects performed five repetitive running trials at a standardized running velocity of 3.5 m/s (± 0.1) for each VA condition. TPR and MPV were measured with an electrogoniometer [1]; cushioning parameters were obtained by vertical GRFs and tibial acceleration. In study A (n = 11) a custom-made running shoe with an experimental midsole/outsole construction consisting of easily removable structural elements that altered VA to 0°, 1°, 2°, 3°, and 4° was used. Study B (n = 10): Four regular EVA running shoe pairs were used to manifest the results of Study A. The midsoles of these shoes were abraded on the lateral side of the heel to create VA of 1°, 2°, and 3°. Study C (n = 17): Subjects performed a 40–60 mins run with in each VA condition from study B at self-selected pace. Directly after each run, perception ratings of rearfoot motion control, cushioning, and comfort properties were collected using a questionnaire. For comparison of the VA conditions one-way repeated measures ANOVA ($p < .05$) including LSD post-hoc tests, when appropriate, were run on all biomechanical parameters.

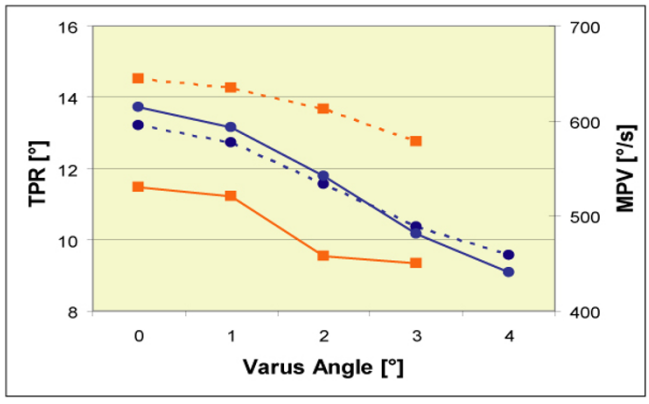

Figure 1
TPR (dotted) and MPV (solid) at different VA (study A squares, study B circles).

Results

Laboratory studies A and B showed highly significant reductions of TPR ($p < .001$) and MPV ($p < .001$) with increasing VA (Figure 1). Although the overall trend was highly significant, post-hoc tests of study B showed that changes of 1°-VA were insufficient to alter TPR and MPV statistically.

Between VA conditions no significant differences were found in tibial acceleration (A: $p = .79$; B: $p = .70$), peak passive vertical force (A: $p = .42$; B: $p = .13$), and peak passive vertical force rising rate (A: $p = .89$; B: $p = .06$). Perception results revealed no differences between conditions for any of the questioned parameters.

Conclusion

VA between 0–4° can gradually control TPR and MPV without negative effects on cushioning properties of the shoes. Subjects do not perceive the effects of VA alteration from 0 – 3° in regular EVA running shoes. Long-term effects of increased VA on overuse injuries need to be studied.

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References

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