

## THE RELATIONSHIP BETWEEN FOREFOOT FLEXIBILITY AND IN-SHOE MEASUREMENTS

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**INTRODUCTION:** An understanding of how modifications to footwear affect athletic performance is key to footwear design and athlete safety. Robust forefoot construction in cleated footwear is intended to provide protection to the forefoot and evenly distribute plantar pressures. This study explores the relationship between footwear forefoot flexibility and athletic performance by measuring metatarsophalangeal joint (MPJ) extension, plantar pressures and overall liking.

**METHOD:** Three footwear conditions were developed to provide three levels of forefoot flexibility. The shoes were mechanically tested to verify that the conditions were meaningfully different. Athletes were then tested in a three part study

- Average peak plantar pressures were measured to explore differences in pressure distribution
- MPJ extension was measured to explore in-shoe forefoot extension
- Subject shoe preference while completing an obstacle course was recorded

**RESULTS:** Statistical differences in peak pressures were found under three regions of the foot: hallux, central metatarsal heads, 5<sup>th</sup> metatarsal head (Table 1).

Table 1 – Average Peak Pressures (red > blue,  $p < .10$ ).

Shoe	Hallux	LatToes	Met1	Met2-4	Met5	Heel
H	467.14	243.65	454.12	393.43	308.75	264.18
I	512.56	232.51	480.39	381.95	329.45	267.35
J	481.17	232.69	467.32	369.67	341.70	254.77

MPJ extension data have not yet been collected.

The stiffest condition ranked last in perceived linear acceleration, cutting speed and overall stability. The middle condition ranked the best in the same three perceived attributes.

**DISCUSSION:** The data supports shoe forefoot stiffness as a factor in protection of the forefoot, with 5<sup>th</sup> met head pressure increasing in response to decreasing forefoot stiffness and central met head pressures increasing as forefoot stiffness increases. As expected, heel pressures were not affected by changes to forefoot stiffness. The lack of a linear relationship between forefoot stiffness and overall liking highlights the complications of making conclusions about athlete performance and forefoot stiffness in a dynamic sport. These data suggest there is a continuum between forefoot stiffness and “feel for the ground” in a dynamic sport. The relationship to MPJ extension has not yet been studied.

**CONCLUSION:** A stiffer forefoot in footwear has been shown to improve linear running times and leaping abilities. Often, a stiffer forefoot is used to provide a level of protection to the foot in cleated sports. This study highlights the relationship between forefoot stiffness in football cleats and how that impacts athletic performance.