

# Shoe stiffness and pressure patterns

By Katie Bell

Pressure measurement technology can differentiate between the impact forces of a stability shoe and a flexible shoe during gait, according to a preliminary study presented in August at the annual meeting of the American Society of Biomechanics in Long Beach, CA.

Researchers from Indiana's Valparaiso University found that walking in a flexible shoe was associated with increased duration of contact at the heel compared with a stability shoe.

"Shoes that are overly flexible in the midfoot region may delay the off-weighting or dorsiflexion of the calcaneus. This can have potential detrimental effects on foot and lower extremity function," said Bruce Williams, DPM, one of the researchers and a podiatrist in private practice in Merrillville, IN.

The preliminary study of one 21-year-old man compared the impact force profiles produced throughout gait with two different running shoes from the same shoe company.

The flexible shoe featured flexion near the midfoot region of the shoe, while the stability shoe flexed closer to the ball of the shoe.

An in-shoe pressure measurement system was used to map the force versus time profile for each shoe type as the participant walked 30 feet.

"In-shoe pressure had not been used to differentiate potential differences in function from shoes of these types and their potential effects on foot function," Williams said.

In order to evaluate the transition between the heel and ball of the foot, force measurements were recorded for the heel, the ball, and the entire sole of the foot. Three trials for each shoe type were undertaken. To compare force profiles across trials, heel strike to toe off (one period) was truncated and normalized to the time associated with that period.

Force versus time was analyzed for the heel and the ball in order to observe slope variation and compare periods in which impact force was constant. This dwell in the gait cycle represents prolonged ground contact.

The results indicate a significantly longer dwell period in

the heel region for the flexible shoe compared with the stability shoe ( $p < 0.05$ ), at 0.1663 seconds compared with 0.0959 seconds. There were no significant dwell periods in the ball region for either shoe.

Prolonged pronation associated with a lack of midfoot support in the flexible shoe explains this dwell period, according to the researchers. They suggest this may be compensatory pronation in response to a lack of ankle joint dorsiflexion. Although no dwell period was evident for the ball of the foot, the researchers suggested this may not be the case in future studies with additional participants.

There is a definite clinical usage for the pressure measurement technology used in this study, said Williams. The technology holds potential for identifying effects of different shoe construction features on lower extremity mechanics and how those changes can result in pain and impaired function, he said.

The researchers plan to collect further data from a variety of subjects with varying foot types, gender, age, and weight.

"These studies may help design better shoes and help match the shoe construction to activity or foot type," said Smita Rao, PhD, PT, assistant professor of physical therapy at New York University.

There are a number of questions that remain unanswered with regard to shoe stiffness and pressure patterns.

"Stability and flexible shoes may alter load distribution patterns. This may contribute to the user's perceived comfort," Rao said. "Differences in magnitude of regional loading are not discussed [in the pilot study]. It would be helpful if the authors related their findings to specific features of the shoes."

Further trial data are being examined, said Williams. "Such data have the potential to clarify unanswered questions, such as 'What other sporting shoe types potentially have an impact like this?'" he said.

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