

Effect Of Terrain On Foot Pressures During Walking

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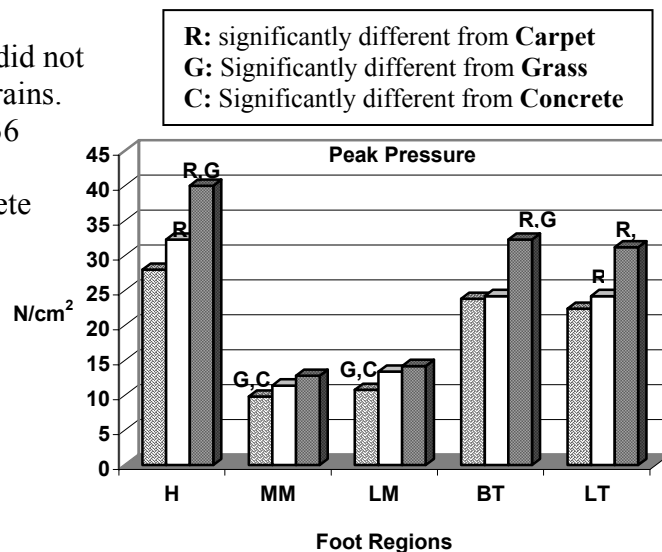
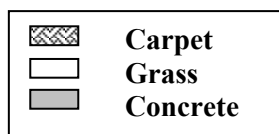
Introduction: Peripheral neuropathy is a common complication of diabetes that causes loss of protective sensation associated with increased risk for ulceration¹ and amputation². Repetitive application of pressure during walking is the most common factor to cause the development of foot ulcers^{3,4}. High plantar pressures have been associated with the development of foot ulcers^{3,4}. Individuals with insensate feet are not cued to use compensatory protective mechanisms to reduce pressure on sore regions of the foot. Strategies to decrease plantar pressures in patients with sensory neuropathy are mostly directed toward the use of custom shoe inserts and custom footwear. Walking surfaces have not been thoroughly addressed. Although non-compliant surfaces are expected to increase plantar pressures, the impact of the walking surface on the magnitude of foot plantar pressure has not been well documented.

Statement of Clinical Significance: Knowledge of the impact of walking on different surfaces would improve patient education and strategies to decrease ulceration in patients with sensory neuropathy.

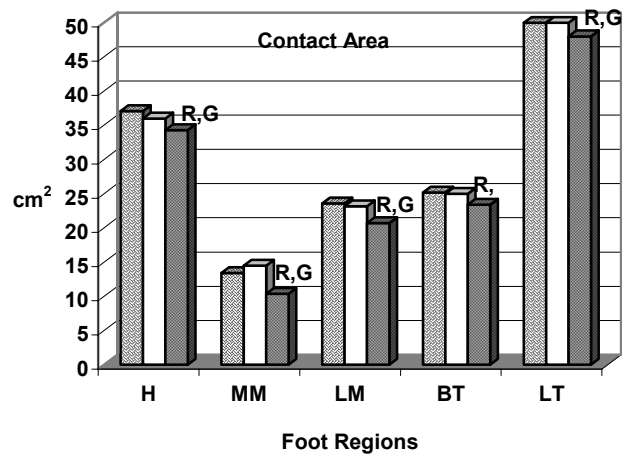
Methodology: Twenty 23-40 year old subjects (6 men and 14 women) with no known musculoskeletal pathology. A Novel Pedar® insole system was used to record plantar pressure during a 15-meter walk on three terrains; Padded carpet over concrete (R), grass (G) and concrete (C). Insole buffers, approximately two millimeters thick, were used to minimize noise from the ground during data collection. The Pedar insoles and insole buffer were secured to the foot with a knee-high nylon stocking and adhesive skin tape. Pressures were collected at 50 Hz and the sole of the foot was divided into 5 regions; Heel (H), lateral midfoot (LM), medial midfoot (MM), big toe and 1st metatarsal head (BT) and lateral toes and metatarsal heads (LT). ANOVA for repeated measures was used to identify significant differences in peak pressure (PP), contact area (CA) and mean force (MF) across terrains. Post hoc t tests used a Bonferroni adjustment to the overall alpha level of .05.

Results: The subjects' walking speed did not significantly differ across the three terrains. Average speed ranged from 1.34 to 1.36 meters/sec.

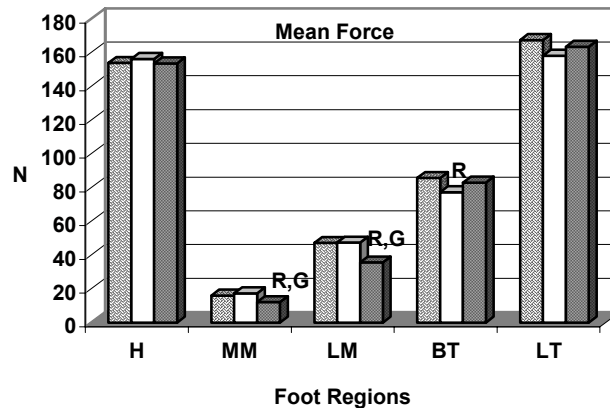
Peak Pressure (PP): Walking on concrete was associated with significantly higher peak pressure than walking on grass and carpet for all foot regions except for the MM and LM.



Contact Area (CA): Foot contact area on concrete was significantly smaller than CA on grass or carpet for all regions of the foot. CA between grass and carpet was not significantly different for any region of the foot.



Mean Force (MF): Mean force was significantly lower when walking on concrete than on carpet and grass in the two regions of the midfoot but was similar between the three terrains for H and LT. MF was lower on grass than on carpet and concrete for BT.



Discussion: Walking barefoot on concrete resulted in higher peak pressures than walking on grass or carpet in all areas of the foot except in the midfoot region. The mean differences in peak pressure between concrete and grass and between concrete and carpet ranged from 6 to 42% across the foot regions. The lateral toes region (with corresponding metatarsal heads), which the most common site for ulceration, had a 39% increase in PP on concrete over walking on carpet. Pressure increases if force increases and/or contact area decreases. The increase in pressure when walking on concrete compared to walking on grass or carpet in this study was due to a decrease in contact area.

Based on these results, we recommend that patients with insensate feet avoid walking barefoot on concrete or other hard surfaces to avoid increased plantar pressures. Most kitchen floors are made of tiles or linoleum, laid over concrete or wood, providing a relatively noncompliant surface which might result in high pressures when walking barefoot. Covering hard kitchen floors with non-slip padded rugs might help decrease plantar pressures and the risk of ulceration in patients with sensory neuropathy.

References:

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2. Bild DE, et al. Diabetes Care 1989;12:24-31.
3. Armstrong DG, et al. J Rehabil Res Dev 1998;35:1-5.
4. Brand PW. Phys Ther 1979;59:8-12.