

REFERENCE

Burnfield JM, Few CD, Whitney JA, Taji SS, Chambers RB, Perry J (2004). Influence of PEDAR-based insert modifications on walking plantar pressures in persons with diabetes mellitus. *Proceedings, Ninth Annual Gait and Clinical Movement Analysis Society Meeting*, pgs. 78-79.

ABSTRACT

Introduction

Elevated plantar pressures have been associated with an increased risk of ulceration and amputation in persons with diabetes mellitus (DM).¹ Preservation of the patient's limb depends, in part, on reducing the injurious pressures experienced while walking. While shoe inserts are frequently used to reduce abnormal pressures,² their overall effectiveness is often identified in retrospect. If no ulceration develops then the insert is considered effective. Now, with the availability of pressure measuring devices that fit within the shoe, it is possible to measure pressures and correct inadequate inserts prior to delivery. Mueller and colleagues' study of a single subject's response to the use of in-shoe pressure measurement for insert modification showed good potential for reducing pressures and the incidence of ulceration.² Insert modification resulted in approximately a 30% reduction in pressure over the site of previous ulceration. The purpose of the current study was to determine the influence of PEDAR-based insert modifications on walking forefoot pressures in a cohort of persons with DM who were at risk for ulceration.

Statement of Clinical Significance

Reduction of skin ulceration is critical for preventing amputations, preserving maximum independence in living and employment, and decreasing the negative emotional and financial consequences associated with managing the disease process and subsequent disability.

Methods

Twenty-one persons at risk for diabetic ulcers due to a previous history of ulcer or unilateral partial foot amputation participated (4 transmetatarsal, 6 ray, 10 toe, and 1 history of ulcers only; mean age=58 yrs). Pressures were recorded (PEDAR by Novel) as subjects walked at a self-selected speed in two footwear conditions: shod with standard inserts (STANDARD), and shod with a tri-laminate custom molded inserts (CUSTOM). The anatomical region of the foot (medial arch, lateral arch, medial metatarsal, central metatarsals, lateral metatarsal, great toe, little toes) with the highest Maximum Mean Peak Pressure (MMPP) was identified for each condition for both the involved and uninvolved limbs.³ The orthotist was provided with an MMPP pictorial plot of the data for any subject whose CUSTOM values exceeded the 21 N/cm² threshold clinically derived by Mueller.² The orthotist modified the insert(s) as indicated and walking pressures were reassessed iteratively until the protective threshold was attained, or no further improvements occurred (MODIFIED). To determine the influence of footwear on MMPP, separate paired T-tests were used to compare the STANDARD and CUSTOM conditions for each limb. A separate set of paired T-tests compared CUSTOM and MODIFIED conditions for inserts requiring modification by the orthotist.

Results

STANDARD vs. CUSTOM (Figure 1): Maximum mean peak pressures were significantly lower while wearing the CUSTOM compared to STANDARD inserts for both the *Involved* (21.1 vs. 25.7 N/cm²; p<0.001) and *Uninvolved* (18.8 vs. 21.2 N/cm²; p<.05) limbs. Walking velocity did not vary significantly between the conditions (51.9 vs. 52.4 m/min).

CUSTOM vs. MODIFIED (Figure 2): *Involved* limb MMPP values exceeded the 21 N/cm² threshold in half of the subjects (n=10) while walking with CUSTOM inserts. Following modification of the *Involved* limb insert, 9 subjects MMPP values were reduced, resulting in an overall trend towards limited improvement (CUSTOM, 25.9 N/cm² vs. MODIFIED, 23.2 N/cm²; p=.09). Four subjects, however, continued to exceed the threshold. *Uninvolved* limb MMPP values exceeded the threshold in 25% of the subjects (n=5) during the CUSTOM condition. Following modification of the *Uninvolved* limb insert, 3 subjects MMPP values decreased, resulting in a slight MMPP reduction (CUSTOM, 27.1 N/cm² vs. MODIFIED, 23.2 N/cm²; p=.19). Three subjects, however, continued to exceed the threshold.

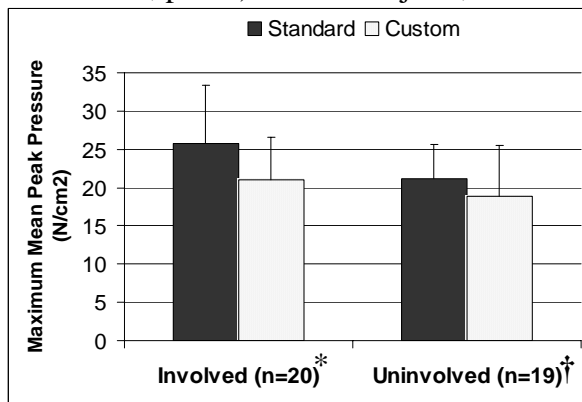


Figure 1. Comparison of maximum mean peak pressures under the involved and uninvolved limbs while walking in STANDARD and CUSTOM inserts (Legend: * = p<.001; † = p<.05).

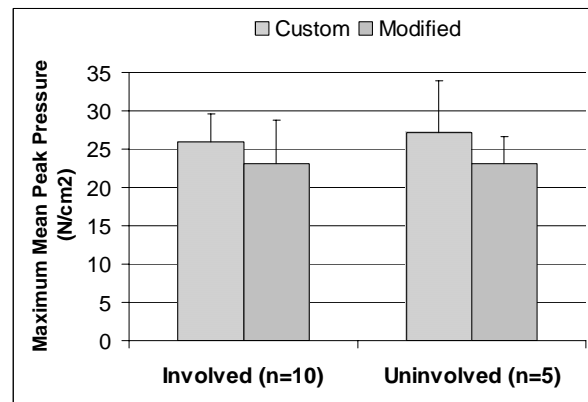


Figure 2. Comparison of maximum mean peak pressures under the involved and uninvolved limbs while walking in CUSTOM and orthotist MODIFIED inserts.

Discussion

Use of CUSTOM inserts significantly lowered pressures under the involved and uninvolved feet of persons with DM at risk for ulceration. PEDAR-based insert modifications further reduced pressure values for subjects whose MMPP values exceeded the clinically defined threshold of 21 N/cm². Continued follow-up of these subjects over the next two years will provide a better indicator as to the appropriateness of this threshold for ulcer prevention.

References:

1. Frykberg RG et al (1998). *Diabetes Care*, 21 (10), 1714-1719.
2. Mueller MJ et al (1999). *Physical Therapy*, 79, 296-307.
3. Bontrager EL et al (1997). *Gait & Posture*, 5, 167-168.

Acknowledgements

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