

## **Pressure Reduction in Therapeutic Footwear: The Effect of Rocker Shoes and Metatarsal Pads**

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**INTRODUCTION:** Approximately 25% of the diabetic population in the United States will develop a foot ulcer during their lifetime [1]. Repetitive high stresses under the metatarsal heads (MTH) can lead to ulceration in the setting of diabetic neuropathy [2]. Prevention of ulcers is of utmost importance in the prevention of lower extremity amputation [3]. Hallux and MTH were found to be the sites of the largest proportion of ulcers [4]. Rocker shoes reduce high pressures under the forefoot by constraining metatarso-phalangeal joint rotations about a single axis [5]. However, maximal reduction in pressures was not possible under both the aforementioned sites simultaneously [5]. A correctly placed metatarsal pad (MTP) is an effective and economical approach to the reduction of peak MTH pressures can diminish the probability of MTH ulcer [6]. The intervention works by transferring the weight bearing force from the MTH to the bone shaft where the pad is located to provide MTH pressure relief [2-5]. This study combines these individually used interventions to investigate the effect of rocker shoe - MTP combination in reducing peak MTH as well as hallux pressures.

**METHODOLOGY:** The study group consisted of 20 healthy subjects with high pressures under second or third MTH in at least one foot and no active foot pathologies. Average age, weight, and height, for all the subjects were  $27 \pm 6$  yrs,  $78 \pm 26$  kg, and  $1.79 \pm 0.7$  m respectively. A standard shoe and insole and a rigid rocker shoe (rocker axis at 67% and rocker angle of  $24^\circ$ ) modified from the standard shoe were used. This rocker shoe design was found to reduce hallux pressures [7]. A medium size MTP made out of compressed felt (Hapad Inc.) was placed on the insole just proximal to the area of peak MTH pressure. The pad type and location used in this study was previously shown to decrease MTH pressures [8]. In-shoe plantar pressures were collected using Pedar insoles (Novel, GmbH; Munich, Germany) at 100 Hz for

at least 80 steps on a treadmill at a speed of 1.5 m/s. Four conditions were tested: standard shoe only, standard shoe with MTP, rocker shoe only and, rocker shoe with MTP. Masks were created over the peak MTH pressure region, MTP location, and lateral and medial part of the foot. Peak MTH and hallux pressure for each step were averaged for each foot for each subject under each shoe condition. Percent reductions in peak pressure (PP) were calculated using the standard shoe as a baseline. Two-way ANOVA was followed by pairwise comparisons using the TUKEY method with 0.05 significance level to explore differences between shoe conditions in their ability to reduce PP relative to the standard shoe.

**RESULTS AND DISCUSSIONS:** ANOVA showed that shoe condition was a predictor of PP ( $p=0.001$ ). Placement of MTP in the standard shoe resulted in an 11% reduction in peak MTH pressure ( $p=0.0012$ ) and, as expected, by an increase in pressure in the MTP region by 35% ( $p<0.0005$ ) (Figure 1). Rocker shoes reduced hallux and MTH peak pressures by 43.5% ( $p<0.0001$ ) and 14% ( $p<0.0001$ ) respectively. When a MTP was inserted in the rocker shoe, 24% decrease in MTH pressure ( $p=0.0237$ ) and 45% increase in MTP region with respect to the standard shoe were observed. Hallux pressures remained unchanged. Results of rocker shoe only and MTP only condition concurred with the values in the literature [7, 8]. Insertion of MTP transferred the load from the peak MTH pressure region to the place where the pad was located. As MTP is very sensitive to its placement (8), resolution of the Pedar insole (1 sensor/cm<sup>2</sup>) might limit its accurate placement. A finite element model of the forefoot, rocker shoe and pad could improve upon the analysis illustrated in this study, to obtain optimal combination characteristics and placement of interventions.

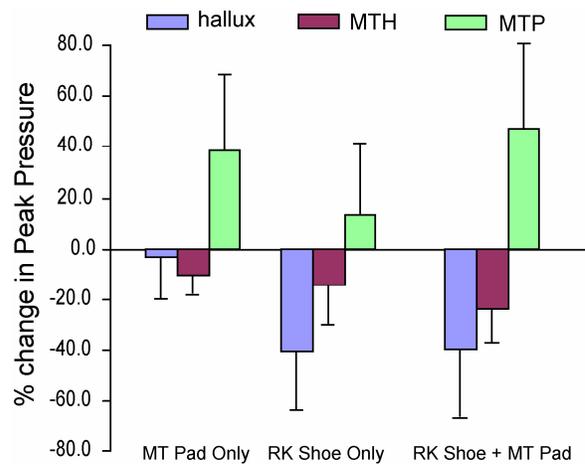


Figure 1. Percent change in peak pressure with respect to standard shoe

## REFERENCES:

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6. Holmes, G. B., Timmerman, L. 1990. Foot and Ankle 11, 141-145.
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## EXPENSES:

ITEMS PURCHASED	NO. OF UNITS	PER UNIT COST (\$)	AMOUNT (\$)
Shoes	11 pairs	85	935
Modifying the shoes	6 pairs	25	150
Canfield Insoles	6	6	36
Plastazote	2 sheets	45	90
Subject Compensation	22 subjects	25	550
Registration fees for Abaqus User's Conference			90
Miscellaneous items (glue, hdd and hdd enclosure)			150
<b>Total</b>			<b>\$ 2001</b>