OFFLOADING THE DIABETIC FOOT USING FOREFOOT OFFLOADING SHOES

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INTRODUCTION

Most plantar foot ulcers in diabetic patients are caused by a combination of neuropathy and elevated plantar pressure and develop in the regions of forefoot and toes. Casting devices (i.e. Total Contact Cast or Mabal shoe) are commonly used for offloading these ulcers. Alternatively, in many diabetic foot centers where casting technicians are absent, prefabricated forefoot offloading shoes (FOS) are used for ulcer treatment. However, little is known about the biomechanical effectiveness of the FOS. Therefore, the purpose of this study was to assess the effectiveness of FOS in offloading the forefoot in diabetic patients with peripheral neuropathy.

METHODS

Twenty-four diabetic patients (20 men, 4 women) with peripheral neuropathy participated. Mean (SD) age, height, and weight was 60.0 (7.0) years, 1.72 (0.07) m, and 92.0 (15.2) kg, respectively. Loss of protective sensation due to neuropathy was confirmed using a 10-grams monofilament. Four FOS were tested: the Thanner Cabrio (www.thanner-gmbh.com), Rattenhuber Talus (www.rattenhuber.de), Fior&Gentz Hannover, and Fior&Gentz Luneburg (www.fior-gentz.de), together with a Pulman shoe (www.fld.fr) used as control condition. The Mabal fiberglass cast shoe was also added for comparison [1].

Patients walked at their own preferred speed across a 18-m walkway wearing the test shoe on the right foot and their own shoe on the left foot. Shoes were randomly assigned to each patient. In-shoe plantar pressure was measured using the Pedar system (Novel, Germany). A minimum of 20 steps in 3 trials were collected. Walking speed was measured using a stopwatch. Peak pressure, pressure-time integral (PTI), and force-time integral (FTI) were calculated for 6 different anatomical foot regions: heel, midfoot, MTH1, MTH2-5, hallux, and lesser toes. Comfort of walking was assessed on a scale from 0 (very uneasy) to 10 (very easy). ANOVA was used for statistical comparisons between the shoes ($P < 0.05$).

RESULTS

Walking speed varied from 1.99 m/s in the F&G Luneburg to 2.07 m/s in the control shoe and was not significantly different between shoe conditions. At the MTH regions, peak pressure and PTI were significantly reduced (by 38-58%) in all FOS and the Mabal cast shoe when compared with the control shoe (Table 1) ($P<0.001$). Loading (FTI) of the heel was similar between shoe conditions, but midfoot FTI was substantially increased in the FOS when compared with the control shoe (up to 162% in the F&G Luneburg). Walking comfort varied substantially between conditions with the control shoe being the most comfortable and the F&G Luneburg the least comfortable shoe (Table 1).

DISCUSSION

All four FOS were equally effective in offloading the forefoot of the neuropathic diabetic patients, with only minor differences between the shoes. The action of the FOS to transfer pressure from the forefoot to proximal regions was clearly illustrated by the substantially increased midfoot loads when compared with the control shoe. Compared with the Mabal cast shoe, which has been shown to be effective in healing relatively small neuropathic plantar ulcers [1], the FOS reduced MTH peak pressure to a greater extent. Although we do not know how much offloading is required to heal ulcers, these data suggest that the FOS may be effective for this purpose. We are currently studying the efficacy in healing neuropathic plantar forefoot ulcers using the FOS. Due to its low perceived comfort of walking, the Fior&Gentz Luneburg should not be used as therapeutic shoe for diabetic patients.

REFERENCES

1. Hissink et al. *Foot and Ankle* **21**, 320-323, 2000.

ACKNOWLEDGEMENTS

The authors are grateful to Michelle Evans and Sally Rees-Mathews for their contributions to this study.

Table 1: Mean (SD) results for pressure data and walking comfort

Shoe condition	Peak pressure (kPa)		Pressure-time integral (kPa.s)		Force-time integral (N.s)		Walking comfort
	MTH1	MTH2-5	MTH1	MTH2-5	Midfoot	Heel	
Control shoe	364 (102)[a]	272 (90)[a]	93.1 (35.9)[a]	75.8 (30.3)[a]	28.2 (38.5)	110.6 (22.1)	8.2 (1.5)[c]
Thanner Cabrio	153 (43)	128 (42)	50.0 (17.4)	44.2 (19.0)	58.2 (38.9)	105.6 (36.6)	5.9 (2.4)
Rattenhuber Talus	156 (40)	130 (46)	47.0 (14.8)	46.2 (21.4)	66.3 (41.7)[b]	92.6 (31.3)	4.6 (2.4)
F&G Hannover	165 (43)	127 (48)	55.7 (19.6)	46.9 (17.9)	66.3 (44.2)[b]	88.8 (29.7)	4.7 (2.5)
F&G Luneburg	153 (57)	135 (43)	50.2 (20.5)	45.3 (18.7)	73.8 (53.6)[b]	111.0 (46.7)	2.7 (2.2)[a]
Mabal cast shoe	203 (65)	166 (59)	54.2 (22.0)	46.6 (18.6)	61.6 (39.0)	86.6 (23.4)	6.8 (1.9)[d]

Significantly different to [a]any other condition, [b]control shoe, [c]all other FOS, and [d]Rattenhuber and both F&G shoes ($P<0.05$)