THE EFFECT OF OFFLOADING INSOLES ON GAIT KINEMATICS AND THE IMPLICATIONS FOR PLANTAR PRESSURE MANAGEMENT.

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Introduction

1.5 million deaths each year are directly attributed to diabetes and 422 million people currently suffer from diabetes around the world which is expected to rise to 643 million people by 2030 [1]. 25% of people with diabetes develop a diabetic foot ulceration (DFU) at some point in their lifetime [2] and about £650 million is spent by the NHS on DFU annually in England [3]. DFU prevention using early intervention of offloading footwear or insoles has been shown in the literature to be an effective strategy to reduce the risk of the formation of DFU [4]. This research aims to describe the effect of offloading insoles on gait kinematics and plantar pressure throughout the gait cycle.

Methods

Pilot data was collected on one 26-year-old male healthy subject (height: 176 cm, weight: 95 kg) walking at a self-selected speed on a treadmill. Three types of 10 mm thick insoles were used to offload high-risk foot regions: no offload (control), large calcaneus offload (LCO) and large first metatarsal head offload (LMHO). Measurements of gait kinematics, plantar pressure and ground reactions forces were taken with a 12-camera motion capture system (100 Hz, Miqus M3, Qualisys AB, Gothenburg, Sweden), an in-shoe plantar pressure measurement system (100Hz, F-Scan, Tekscan Inc., Norwood, MA, USA) and a split belt-instrumented treadmill (1000Hz, M-Gait, Motek Medical BV, Amsterdam, Netherlands).

Data was processed for presentation using custom MATLAB code and F-Scan Research 7.0 software.

Results

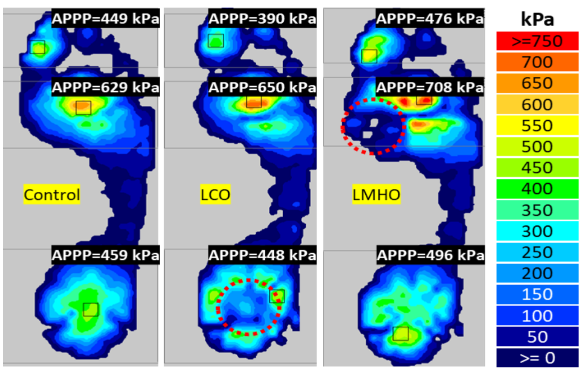

Figure 1: The average peak plantar pressure (APPP) for the three insole conditions. The red dash circles indicate the offloading shape. The small square outlines indicate the location of peak plantar pressure.

	Control	LCO	LMHO
Average peak plantar pressure (kPa)			
Toes region	449	390	476
Metatarsal heads region	629	650	708
Calcaneus region	459	448	496
Pressure time integral (kPa·s)			
Toes region	28.1	31.4	27.3
Metatarsal heads region	64.8	68.7	67.0
Calcaneus region	65.5	61.9	73.1
Ankle heel strike velocity (m/s)			
Vertical to ground	0.248	0.270	0.255

Table 1: Plantar pressure and kinematic data for the three insole conditions.

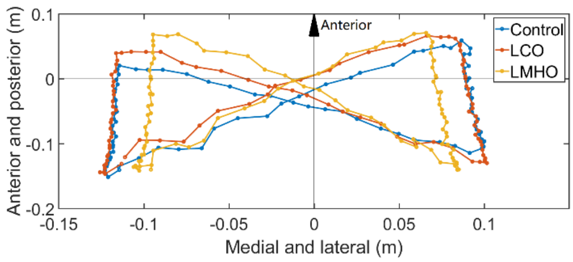

Figure 2: Mean centre of force position (CoF) of 10 gait cycles when applying different insole conditions at self-selected walking speed. CoF is measured through an instrumented split belt treadmill with the origin normalized from optical camera measurements of sternum marker position (calculated using MATLAB).

Discussion

This study shows that offloading insoles can decrease the calcaneus centre plantar pressure by 46% shown in Figure 1, which is also seen in other studies [4]. For the calcaneus and metatarsal head offloading condition we observe an 8% and 3% increase in heel strike velocity respectively. This kinematic change both increases plantar pressure and pressure-time integral in other regions as shown by increased peak pressure in metatarsal head region for in LCO condition and calcaneus in LMHO condition. Also for the first metatarsal head offloading condition, we observe a 20% narrower stance in gait, which may create stability problems. Whilst this study only presents results from one healthy subject it demonstrates offloading insoles work by both loading other areas of the foot and by changing gait kinematics. Further testing on diabetics and more participants is required for robust conclusions.

References

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