

The effects of off-the-shelf in-shoe heel inserts on forefoot plantar pressure

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Received 26 October 2007; received in revised form 10 March 2008; accepted 11 March 2008

Abstract

Off-the-shelf heel inserts are used widely without adequate scientific information regarding their effects upon the forefoot. The aim of this study was to assess whether the use of in-shoe heel inserts affects the plantar pressure distribution under the forefoot. Thirty-five asymptomatic volunteers consented to participate. Six brands of off-the-shelf heel inserts were tested. Subjects walked along a 10 m walkway with no inserts and then with each pair of inserts, in a randomised order. The Pedar[®] system was used to record in-shoe plantar pressure data. The results confirmed that heel inserts increased pressure under the metatarsal heads and altered the biomechanics of the foot even in asymptomatic subjects. The findings suggested that heel inserts should be used with caution especially in people predisposed to foot problems. The classification of these inserts as an over-the-counter product may need to be reviewed.

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Keywords: Pedar[®]; In-shoe heel inserts; Foot; Pressure

1. Introduction

Research has been carried out on the role of the foot, with its complex structure, as a shock absorber [1]. The natural bony arches and the ligamentous complex act as static shock absorbers. The pronation of the subtalar joint, eversion of the calcaneus and plantar flexion of the talus in relation to the calcaneus that occurs during heel strike are considered to be the dynamic dampers. Repeated trauma to the heel could reduce heel-pad shock absorbency by up to 24% [2]. In-shoe heel inserts are intended to assist the endogenous shock absorption mechanism in protecting structures in close proximity to them, as well as to dissipate effectively the ground reaction forces under the heel, generated at heel strike.

Shock-absorbing heel inserts have long been advocated for use by people suffering from heel pain [3,4]. The symptomatic relief they provide, especially in over-use

injuries, has been documented [5]. The availability of off-the-shelf inserts along with the growing exercise culture has led to an increase in their regular application. However, no scientific evidence exists on their effects on forefoot plantar pressure. The choice of insert could be bewildering to most people. This is mainly due to the vast variety available over-the-counter. The cost and availability, rather than efficacy, are probably the overriding considerations for buying a specific heel insert.

The pressure shock generated at heel strike during gait and the reduction of this shock when using heel inserts have been quantified [6,7]. Heel inserts are assumed to attenuate ground reaction forces in several ways. By virtue of their viscoelastic nature they are believed to exert a dampening effect and thus aid in shock wave dissipation [4]. Windle et al. stated that viscoelastic insoles did not attenuate vertical forces when running at 4 m/s in running shoes, although when placed in standard shoes they reduced the peak acceleration of the lower extremity [8]. Their shape and compliance are such that they are thought to increase the area of contact between the heel and the shoe, thereby

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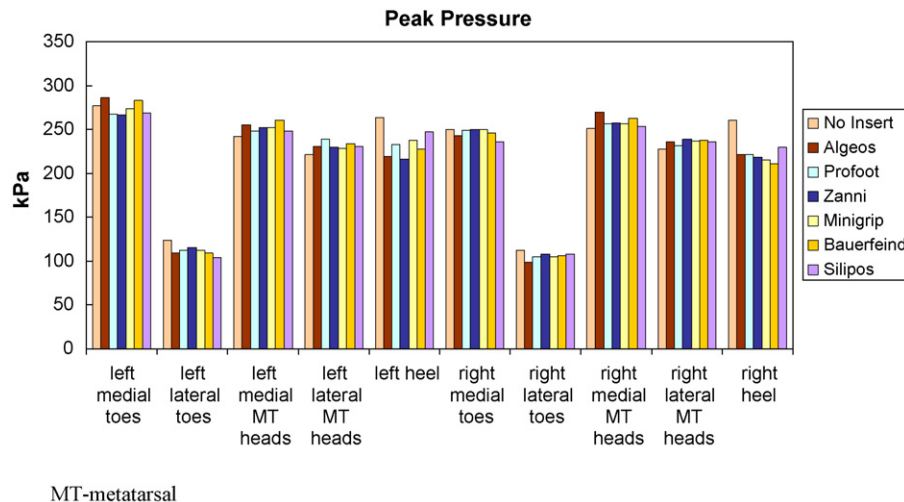


Fig. 1. Peak pressure data for the different areas of interest.

reducing the pressure by distributing it over a greater area (pressure = force/area). Shock absorbing properties may however be influenced by other external factors such as the rate of loading and the nature of ground surface [9]. In addition, the right and left foot of the same individual often have different dimensions and in some instances, varied hindfoot to forefoot alignment. The hindfoot and forefoot alignment measures have been used to identify three foot types: rectus, cavus and planus [10]. Hence inserts should ideally be custom-made. The prohibitive cost of the latter has resulted in the mass production and ease of availability of off-the-shelf heel inserts.

Heel height variations in footwear and their effects on the rate of loading, pressure–time integral and maximum peak pressure have been reported extensively [11–14]. Snow and Williams reported that vertical forces applied to the forefoot during standing increased proportionately with increasing heel heights [15]. The purpose of this study was to determine the effects of over-the-counter in-shoe heel inserts on forefoot plantar pressure.

2. Materials and methods

Ethical approval was granted for the study and volunteers were sought. Subjects with previous foot and ankle injuries, foot disorders, unequal limb lengths and those using walking aids were excluded. Thirty-five asymptomatic participants were recruited: 7 women (20%) and 28 men (80%). The mean age was 34.6 years (21–50 years). Six brands of over-the-counter in-shoe heel inserts were purchased from local pharmacies, purely on the basis of them being available in all sizes: silicone heel spur cup with central spot (manufactured by Algeo'sTM), Gel-max advanced gel and Poron[®] design with extra thick poron centre (ProfootTM), gel support silicone therapeutic under-heel (ZanniTM), silicone heel cushions (MinigripTM), Viscopspot[®] viscoelastic heel cushions (BauerfeindTM) and WonderZorb[®] medical grade biomechanical silicone heel cushions with soft density dots (SiliposTM).

Subjects walked at their natural self-selected speed wearing the standardised off-the-shelf neutral running shoe, once without any inserts and once with each pair of inserts. The order of testing of inserts was randomised using a Latin square design. In order to standardise the walks, all data were recorded on a 10 m walkway. The first and last footsteps were excluded from the analysis.

The Pedar[®] mobile (Novel_{gmbh}, Germany) pedobarography system was used to record in-shoe plantar pressure. Its accuracy and repeatability have been validated [16,17]. The Pedar[®] insoles were checked on a daily basis before and after recording the data for accuracy. Five areas of interest were selected for each footprint using the multimask evaluation software: the heel, lateral three metatarsal heads, medial two metatarsal heads, lateral three toes and medial two toes (refer to Masks (electronic addenda)). The variables chosen for analysis were peak pressure (PP) in kPa, contact time (CT) in ms and percentage roll over process (%ROP),¹ beginning of contact (BoC) in %ROP, and pressure–time integral (PTI) in kPa s.

3. Statistical methods

Repeated measures analysis of variance was used to investigate the effects of inserts on parameters measured under the foot. The standard checks for violations of the assumptions underlying the ANOVA procedure were carried out. The Huynh–Feldt correction was applied for non-sphericity, where appropriate. The Bonferroni correction for multiple comparisons was applied when means were compared post hoc. The significance level chosen was 5%.

4. Results

The mean PP recorded in each area of interest with and without inserts is presented in Fig. 1 (and Table 1 (electronic

¹ For each step (foot): Parameter (%ROP) is calculated as Parameter (ms) / Contact time (ms) * 100%, where Parameter (ms) is calculated in mask and for step (foot). Contact time (ms) is calculated for step (foot).

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