

# Effect of foot orthoses on the kinematics and kinetics of normal walking gait

C.J. Nester<sup>a,\*</sup>, M.L. van der Linden<sup>b</sup>, P. Bowker<sup>a</sup>

<sup>a</sup> Centre for Rehabilitation and Human Performance Research, Brian Blatchford Building, University of Salford, Salford M6 6PU, UK

<sup>b</sup> Rehabilitation Engineering Services, Eastern General Hospital, Edinburgh, UK

Received 20 March 2002; received in revised form 30 May 2002; accepted 6 June 2002

## Abstract

Despite their wide clinical application and success, our understanding of the biomechanical effects of foot orthoses is relatively limited. The aim of this study was to assess the effect of medially wedged and laterally wedged foot orthoses on the kinematics and joint moments of the rearfoot complex, knee, hip and pelvis and the ground reaction forces. The principal effect of the foot orthoses was on the rearfoot complex, where significant changes in joint rotations and moments were observed. Medially wedged orthoses decreased rearfoot pronation and increased the laterally directed ground reaction force during the contact phase, suggesting reduced shock attenuation. The laterally wedged orthoses increased rearfoot pronation and decreased the laterally directed ground reaction force during the contact phase, suggesting increased shock attenuation. The effects of the orthoses on knee, hip and pelvis kinematics were generally minimal. In view of the minimal effect the orthoses had on joints proximal to the foot, it is suggested that the orthoses may have additional effects on the passive and active soft tissues of the lower limb and it is these changes that result in the documented clinical success.

© 2002 Elsevier Science B.V. All rights reserved.

*Keywords:* Kinematics; Orthoses; Pronation; Kinetics; Foot

## 1. Introduction

Evidence relating to the clinical efficacy of foot orthoses in the management of a variety of lower limb disorders is widely available in the literature [1–14]. In contrast, descriptions of the biomechanical effects of foot orthoses on the lower limb, that is the mechanisms through which we believe the clinical benefits are derived, are comparatively limited. It has been reported that medially wedged foot orthoses reduce the range of rearfoot pronation during stance [15–17], the maximum angle of calcaneal eversion, maximum calcaneal eversion moment during stance [18] and the range of internal tibial rotation associated with rearfoot pronation during running [19]. Eng and Pierrynowski [17] reported that medially wedged orthoses resulted in a decrease in the range of frontal and transverse plane motion at the knee

during the contact and mid stance phases of gait, although the effects were less than 1 and 2°, respectively for the frontal and transverse planes. Lafortune et al. [20] described effects of a similar magnitude during running with a medially wedged shoe. None of these studies have reported data for the whole lower limb and pelvis, which would provide a more complete understanding of the effect of foot orthoses. Whilst the majority of investigations concentrate on medially wedged foot orthoses, designed to reduce rearfoot pronation, laterally wedged foot orthoses have had favourable reports with respect to the management of medial compartmental osteoarthritis of the knee [2,21–24], but our understanding of the biomechanical effects of these orthoses is also limited [25,26].

The aim of this study was to describe the effects of medially wedged and laterally wedged foot orthoses on the kinematics and joint moments of the rearfoot complex, knee, hip and pelvis using a sample of asymptomatic subjects. The term rearfoot complex is used to describe the combined motions at the ankle, sub

\* Corresponding author. Tel.: +44-161-295-2275; fax: +44-161-295-2302

E-mail address: [c.j.nester@salford.ac.uk](mailto:c.j.nester@salford.ac.uk) (C.J. Nester).