



Short communication

Intra-rater repeatability of the Oxford foot model in healthy children in different stages of the foot roll over process during gait

D.J. Curtis^{a,b,*}, J. Bencke^a, J.A. Stebbins^c, B. Stansfield^d

^a Gait Analysis Laboratory, Dept of Orthopedic Surgery, Hvidovre University Hospital, Kettegaard Allé 30, DK-2650 Hvidovre, Denmark

^b Dept of Physiotherapy, Hvidovre University Hospital, Kettegaard Allé 30, DK-2650 Hvidovre, Denmark

^c Oxford Gait Laboratory, Nuffield Orthopaedic Centre, Windmill Road, Headington, Oxford O3 7LD, UK

^d School of Health and Social Care, Glasgow Caledonian University, Glasgow, UK

ARTICLE INFO

Article history:

Received 8 August 2008

Received in revised form 13 February 2009

Accepted 18 February 2009

Keywords:

Foot

Kinematics

Repeatability

Instrumented gait analysis

Oxford foot model

ABSTRACT

Background: The repeatability of the Oxford foot model has been reported, but possible variations in the repeatability during the foot roll over process have not been examined. The aim of this study was to determine the relative and absolute repeatability of the model for each stage of the foot roll over process during gait and to compare foot kinematic data from this study with that from another centre as a preliminary examination of the model's inter-centre repeatability and validity.

Method: Eight healthy children were tested twice at the gait laboratory. Foot kinematics from this study were plotted against those from an earlier repeatability study and repeatability statistics calculated for the three rockers of stance phase and swing phase.

Results: Foot kinematics from this study and an earlier repeatability study produced similar kinematic patterns and joint angle ranges, but there were offsets in the absolute joint angles in the frontal and transverse planes. Relative and absolute repeatability were best in the sagittal plane (flexion/extension) with the poorest repeatability in the transverse plane (rotation and abduction/adduction). There was little difference in repeatability between the three rockers. Typical error of measurement varied between planes and segments from 0.98 for maximum forefoot dorsiflexion in second rocker to 8.68 for maximum hindfoot internal rotation in first rocker.

Discussion: Repeatability varied markedly between planes and segments but was consistent throughout the gait cycle. Further studies are needed to determine the inter-centre repeatability and validity of the model.

© 2009 Elsevier B.V. All rights reserved.

1. Introduction

A number of models have been suggested to allow a more detailed analysis of foot kinematics [1–8]. The Oxford foot model appears from two published studies [5,9] to have a good repeatability in healthy subjects but there are no published studies examining the inter-centre repeatability or validity of the model. As this model is used clinically to determine the effect of an intervention on foot kinematics in a given phase of the gait cycle, it was felt that the repeatability of the model should be examined for each of these phases as it was possible that factors such as mechanical loading (e.g. heel pad deformation) and skin move-

ment artefact could mean that repeatability would vary under different phases of the gait cycle.

The aim of this study was therefore to compare foot kinematic data from this study and another centre as a preliminary examination of the model's inter-centre repeatability and validity and then determine the repeatability of the foot model during various phases of the gait cycle.

2. Subjects and method

The foot kinematics during gait of eight healthy children selected at random (three boys mean \pm S.D., 12 ± 3 years, range, 9–18 years) were tested on two separate occasions. The test and retest were scheduled to be within 1 month (23 ± 23 days, range 2–58 days).

The Oxford foot model was implemented according to Stebbins et al. [5]. Three trials of data were recorded for each foot of each subject.

For the purposes of statistical analysis, data from the left foot for each trial were divided into the three ankle rockers as described by Perry [10].

The study complied with the principles laid down in the Declaration of Helsinki and was approved by the relevant local ethical committee (case number KF 07 317863). The subjects and their guardians gave their informed consent to the work.

* Corresponding author at: Gait Analysis Laboratory, Dept of Orthopedic Surgery, Hvidovre University Hospital, Kettegaard Allé 30, DK-2650 Hvidovre, Denmark. Tel.: +45 3632 6248.

E-mail address: derek.curtis@hvh.regionh.dk (D.J. Curtis).

- [11] Menz HB. Analysis of paired data in physical therapy research: time to stop double-dipping? *J Orthop Sports Phys Ther* 2005;35:477–8.
- [12] Menz HB. Two feet, or one person? Problems associated with statistical analysis of paired data in foot and ankle medicine. *The Foot* 2004;14: 2–5.
- [13] Rattanaprasert U, Smith R, Sullivan M, Gilleard W. Three-dimensional kinematics of the forefoot, rearfoot, and leg without the function of tibialis posterior in comparison with normals during stance phase of walking. *Clin Biomech (Bristol Avon)* 1999;14:14–23.
- [14] Hunt AE, Smith RM, Torode M, Keenan AM. Inter-segment foot motion and ground reaction forces over the stance phase of walking. *Clin Biomech (Bristol Avon)* 2001;16:592–600.
- [15] Torburn L, Perry J, Gronley JK. Assessment of rearfoot motion: passive positioning, one-legged standing, gait. *Foot Ankle Int* 1998;19:688–93.