Gait & Posture 49 (2016) 144–147

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Technical note

Shod wear and foot alignment in clinical gait analysis

Melissa Gar Yee Louey[a,*], Morgan Sangeux[a,b,c]

[a] The Royal Children's Hospital, Melbourne, Australia
[b] The Murdoch Childrens Research Institute, Australia
[c] The University of Melbourne, School of Engineering, Australia

ARTICLE INFO

Article history:
Received 19 February 2016
Received in revised form 19 May 2016
Accepted 23 June 2016

Keywords:
Foot
Gait
Kinematics

ABSTRACT

Sagittal plane alignment of the foot presents challenges when the subject wears shoes during gait analysis. Typically, visual alignment is performed by positioning two markers, the heel and toe markers, aligned with the foot within the shoe. Alternatively, software alignment is possible when the sole of the shoe lies parallel to the ground, and the change in the shoe's sole thickness is measured and entered as a parameter. The aim of this technical note was to evaluate the accuracy of visual and software foot alignment during shod gait analysis. We calculated the static standing ankle angles of 8 participants (*mean age: 8.7 years, SD: 2.9 years*) wearing bilateral solid ankle foot orthoses (BSAFOs) with and without shoes using the visual and software alignment methods. All participants were able to stand with flat feet in both static trials and the ankle angles obtained in BSAFOs without shoes was considered the reference. We showed that the current implementation of software alignment introduces a bias towards more ankle dorsiflexion, mean = 3°, SD = 3.4°, $p = 0.006$, and proposed an adjusted software alignment method. We found no statistical differences using visual alignment and adjusted software alignment between the shoe and shoeless conditions, $p = 0.19$ for both. Visual alignment or adjusted software alignment are advised to represent foot alignment accurately.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

Ankle angle is often a key variable in clinical gait analysis. Dorsiflexion and plantar flexion are calculated as the angular rotation of the foot around the lateral axis of tibia [1]. Therefore, the ankle angle is affected by foot alignment in the sagittal plane. The conventional gait model describes the foot as a rod defined by a marker at the heel and dorsal surface of the foot [2,3]. The assessors visually align these markers to the sole of the foot in the sagittal plane and parallel to the long axis of the foot in the coronal plane [3]. The aid of a striped transparent Perspex board may be used (Fig. 1A). However, visual alignment is a subjective and time consuming process as assessors often lay prone on the floor at foot height to minimise parallax error.

Software alignment is an alternative method when the patient can stand barefoot with flat feet, i.e. with the sole of the foot parallel to the ground. Software alignment adjusts the height of the heel marker to match the height of the forefoot marker above the ground [4]. This eliminates the need for sagittal plane alignment and only leaves coronal plane alignment during marker placement. In shod gait analysis, sagittal foot alignment within the shoe is more complex and shod studies may constrain shoe wear to a particular model or have cut outs to improve consistency and accuracy of marker placement [5,6]. In a clinical setting, this approach is impractical and visual alignment is used.

Software alignment in shod analysis may still be possible if the patient can stand with their shoes flat on the ground and the change in shoe sole thickness across the length of the shoe is measured and entered as a parameter, sole delta (Plug-in-Gait, VICON, [4]). Measurement of sole delta is taken at the two major points of contact of the foot within the shoe (Fig. 1B), estimated to be at the metatarsal heads and the centre of the heel [7,8]. However, this may introduce a small dorsiflexion bias since sole delta is applied to the heel marker rather than at the centre of the heel (Fig. 1C). Adjusting sole delta (s_{adj}) to remove the bias requires a measure of the distance between the centre of the heel and the heel marker (d_{heel}). Alternatively, the projection of the ankle joint centre on the sole of the foot may be used as a proxy for the position of the rear contact point.

The aim of this technical note was to quantify the magnitude of the bias and to evaluate the accuracy of the visual and software foot

* Corresponding author at: The Hugh Williamson Gait Analysis Laboratory The Royal Children's Hospital, 50 Flemington Road, Parkville, 3052, VIC, Australia.
E-mail address: Melissa.louey@rch.org.au (M.G.Y. Louey).

http://dx.doi.org/10.1016/j.gaitpost.2016.06.032
0966-6362/© 2016 Elsevier B.V. All rights reserved.

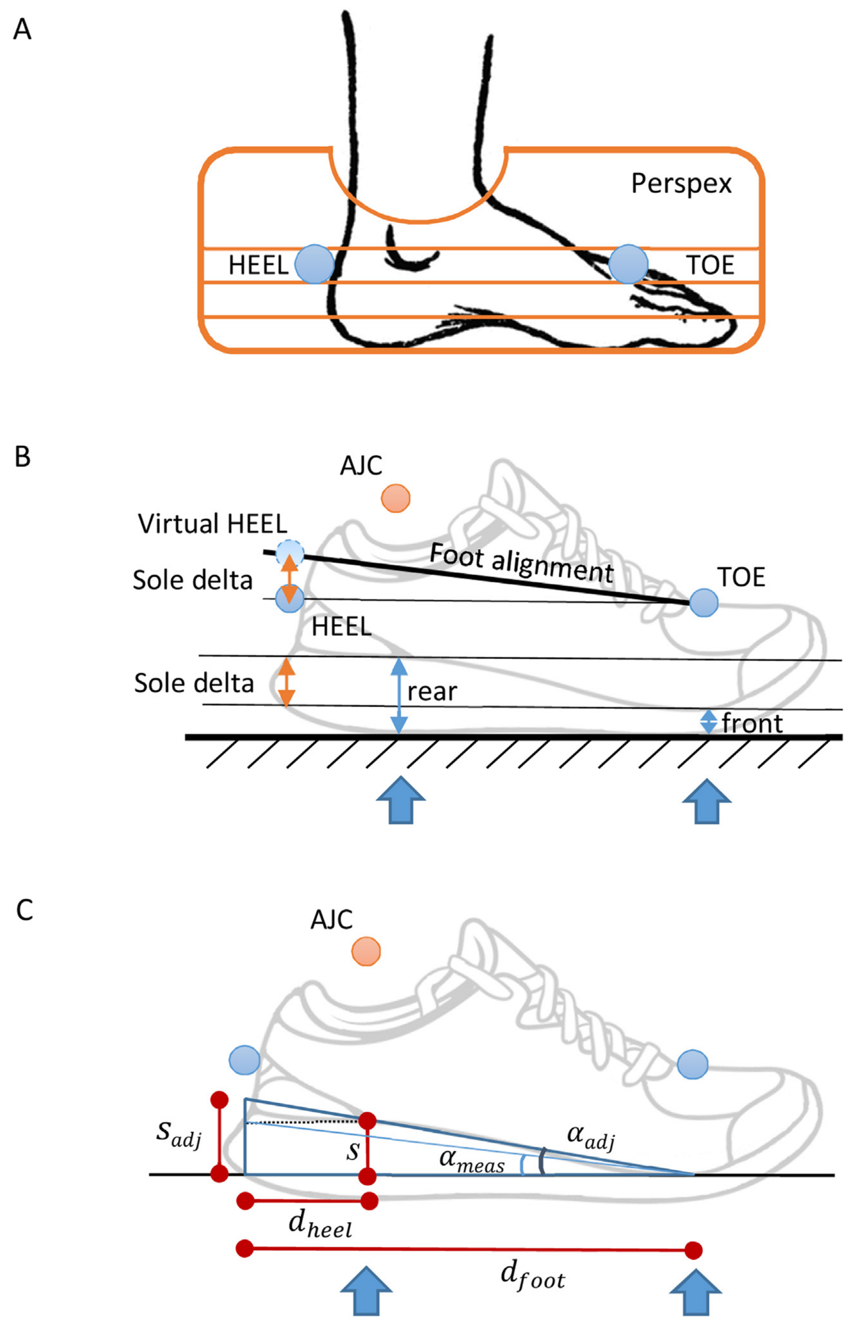

Fig. 1. (A) Example of a Perspex board with a series of parallel lines to aid marker positioning during visual alignment. (B) The thick blue arrows under the shoe indicate the two points of sole height measurement at the heel (rear) and metatarsal heads (front) used to calculate sole delta. Sole delta is added to a pre-levelled HEEL marker to model sagittal foot alignment within the shoe. (C) Visual representation of the variables used to calculate the bias $\alpha_{meas} - \alpha_{adj}$. $\boldsymbol{d_{foot}}$ is the distance on the floor between the HEEL and TOE markers. $\boldsymbol{d_{heel}}$ is the distance on the floor between the HEEL marker and the rear measurement point. $\boldsymbol{\alpha_{meas}}$ is the pitch of the foot calculated when sole delta is applied to the HEEL marker ($\boldsymbol{s}$). $\boldsymbol{\alpha_{adj}}$ is the pitch of the foot when sole delta is applied to the rear measurement point and corresponds to the adjusted sole delta $\boldsymbol{s_{adj}}$ at the HEEL marker.

alignment methods during shod analysis. We also proposed and evaluated an adjusted software alignment method.

2. Materials and methods

Sole delta (s) is the height difference at the rear and front of the shoe (Fig. 1B). The adjusted sole delta (s_{adj}) value is calculated for greater foot alignment accuracy using the principle of similar triangles (Fig. 1C):

$$s_{adj} = \frac{s \times d_{foot}}{d_{foot} - d_{heel}}$$

Where d_{foot} is the distance between the heel and toe markers projected on the floor and d_{heel} is the distance between the heel marker and rear contact point projected on the floor. The location of the rear contact point is a visual estimation. The dorsiflexion bias (α_{error}) is calculated as

$$\alpha_{error} = \alpha_{adj} - \alpha_{meas} = tan^{-1}\left(\frac{s_{adj}}{d_{foot} - d_{heel}}\right) - \tan^{-1}\left(\frac{s}{d_{foot}}\right)$$

Download English Version:

https://daneshyari.com/en/article/6205529

Download Persian Version:

https://daneshyari.com/article/6205529

Daneshyari.com