Reliability and Accuracy of Static Parameters Obtained From Ink and Pressure Platform Footprints

Juan Carlos Zuil-Escobar, PT, MSc, PhD,[a] Carmen Belén Martínez-Cepa, PhD,[a] Jose Antonio Martín-Urrialde, PhD,[a] and Antonia Gómez-Conesa, PhD[b]

Abstract

Objective: The purpose of this study was to evaluate the accuracy and the intrarater reliability of arch angle (AA), Staheli Index (SI), and Chippaux-Smirak Index (CSI) obtained from ink and pressure platform footprints.

Methods: We obtained AA, SI, and CSI measurements from ink pedigraph footprints and pressure platform footprints in 40 healthy participants (aged 25.65 ± 5.187 years). Intrarater reliability was calculated for all parameters obtained using the 2 methods. Standard error of measurement and minimal detectable change were also calculated. A repeated-measure analysis of variance was used to identify differences between ink and pressure platform footprints. Intraclass correlation coefficient and Bland and Altman plots were used to assess similar parameters obtained using different methods.

Results: Intrarater reliability was >0.9 for all parameters and was slightly higher for the ink footprints. No statistical difference was reported in repeated-measure analysis of variance for any of the parameters. Intraclass correlation coefficient values from AA, SI, and CSI that were obtained using ink footprints and pressure platform footprints were excellent, ranging from 0.797 to 0.829. However, pressure platform overestimated AA and underestimated SI and CSI.

Conclusions: Our study revealed that AA, SI, and CSI were similar regardless of whether the ink or pressure platform method was used. In addition, the parameters indicated high intrarater reliability and were reproducible. (J Manipulative Physiol Ther 2016;39:510-517)

Key Indexing Terms: *Flatfoot, Foot Deformities; Foot Diseases; Reliability, Data Accuracy*

Introduction

The foot has important impact absorption and ground reaction force transmission functions in both gait and bipedal standing position.[1] Medial longitudinal arch (MLA) is one of the most important foot structures related to these actions[2] because it participates in the absorption of ground forces.[3]

The height of the MLA has been considered to be a relevant factor in injuries in the lower extremity.[4-6] A high MLA can increase the risk of injuries on the lateral side of the foot, whereas a lower MLA can increase the risk of injuries on the medial side.[5] Changes in MLA height are related to certain injuries, such as tibial stress syndrome,[7,8] patellofemoral syndrome,[9-11] noncontact cruciate anterior ligament injury,[12,13] and low back pain.[14] In addition, the height of the MLA is related to several alignments in the lower limb. A higher MLA is associated with supination, and a lower MLA is associated with subtalar pronation.[15] Changes in the MLA are associated with tibial internal rotation,[16] anterior knee laxity,[17] greater genu recurvatum,[18] and increased pelvis anteversion.[19]

Many different techniques can be used to evaluate the height of the MLA, including radiographs,[20] visual observation,[21] rearfoot angle measurements,[22] navicular tuberosity measurements,[23] and footprint parameters.[24] Many parameters can be obtained from footprints, including arch angle (AA), arch index (AI),[24] Chippaux-Smirak Index (CSI),[25] long plantar arch,[26] and Staheli Index (SI),[27] using ink and digital systems. Ink footprint is a valid method that is used in clinical practice to study foot structure, explore MLA,[24] and diagnose pathologic conditions.[2,20] In addition, ink footprint is a simple, inexpensive, and noninvasive method that can be recorded for future comparisons[28,29] and has correlation with radiologic measures.[30] However, ink footprints have some limitations, such as the inaccuracy of the measurements and the difficulties involved in their interpretation.[2] Nowadays, these limitations have been overcome by the use of digital systems, which provide both qualitative and quantitative data.[2] These systems, including

[a] Nursing and Physiotherapy Department, CEU San Pablo University, Madrid, Spain.
[b] Physiotherapy Department, University of Murcia, Murcia, Spain.
Corresponding author: Juan Carlos Zuil-Escobar, PT, MSc, PhD, Avda De Montepríncipe s/n, 28668, Boadilla del Monte, 28668, Spain. (e-mail: *jczuil@ceu.es*).

Paper submitted January 15, 2015; in revised form July 13, 2016; accepted July 13, 2016.
0161-4754

http://dx.doi.org/10.1016/j.jmpt.2016.07.005

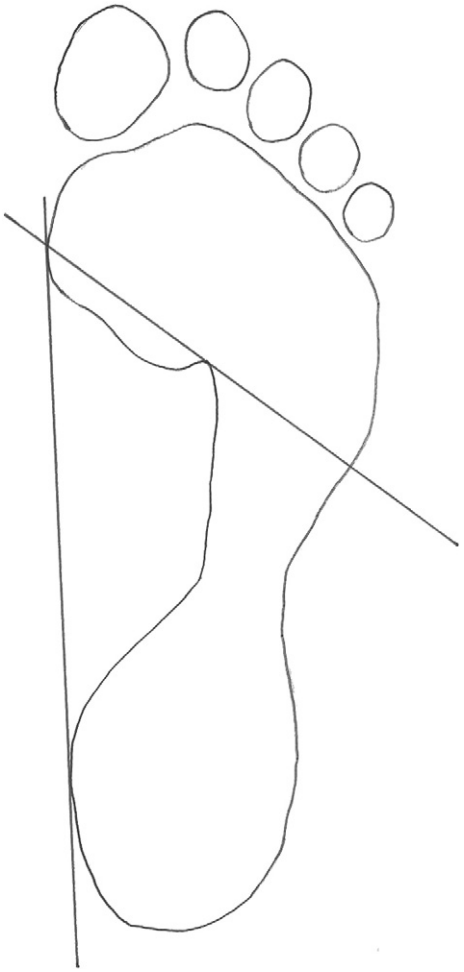

Fig 1. *Arch angle is the angle between the medial line of the footprint and the line connecting the most medial aspect of the metatarsus and the most lateral point of the medial foot.*

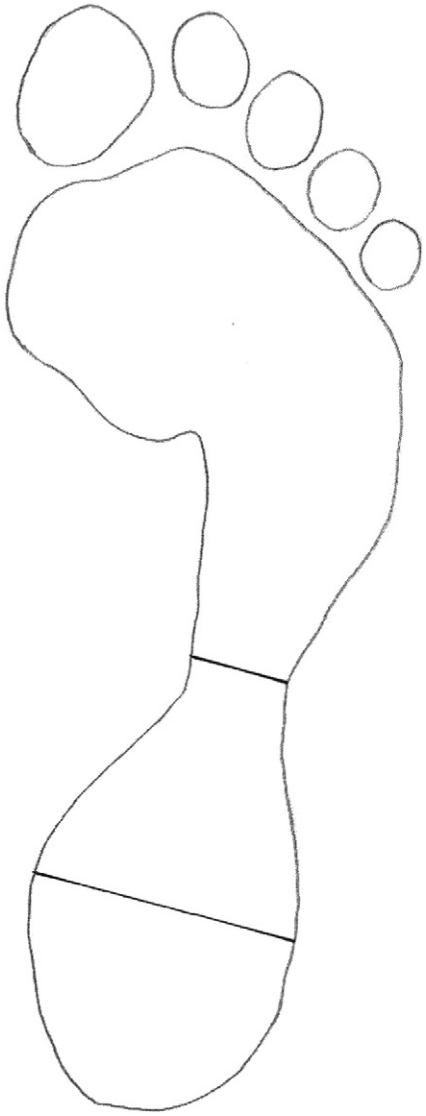

Fig 2. *Staheli Index is obtained by dividing the minimal distance of the midfoot by the widest section of the rearfoot region.*

pressure platforms, are widely used in investigation and clinical practice.[2,27,31,32] Pressure platforms are an easier, though more expensive, means of obtaining footprints.

The aims of this study included the evaluation of the accuracy and significant differences among 3 parameters (AA, SI, and CSI) obtained using ink footprints and pressure platform footprints and the evaluation of the intrarater reliability, standard error of measurement (SEM), and minimal detectable change (MDC) of these measurements for both methods.

Methods

Forty healthy participants (25 women and 15 men) took part in the study after completing a form to ensure that they met the inclusion criteria. The principles outlined in the Declaration of Helsinki of 1975 were observed, and this study was approved by the research ethics committee of the CEU San Pablo University. Each participant was informed about the aims and procedure and completed a consent form before being included in the study. Participants experiencing acute injuries in lower limbs, having undergone surgery, or presenting with deformities in the feet were excluded. Demographic variables including age, sex, height, weight, and body mass index were collected from those who were eligible.

Right feet were studied in each participant.[2] Three parameters were used to measure arch height: AA, SI, and CSI. AA is the angle between the medial line of the footprint and the line connecting the most medial aspect of the metatarsus and the most lateral point of the medial foot (Fig 1).[33] To calculate SI and CSI, 3 lines were drawn: 1 at the maximal distance of the rearfoot, 1 at the maximal distance of the forefoot, and 1 at the minimal distance of the midfoot.[6] The SI is the ratio of the minimal distance of the midfoot to the widest section of the rearfoot region (Fig 2).[25] The CSI is obtained by