Measuring forefoot alignment with a table-mounted goniometric device

Ward Myloe Glasoe¹, Mary K Allen¹ and Paula M Ludewig²

¹Private Practice, Cedar Rapids, Iowa USA  ²The University of Minnesota, USA

Evaluating the need for orthotic treatment may include the measure of forefoot-to-hindfoot alignment. This paper describes a table-mounted goniometric device that improves intra-rater reliability and simplifies the measurement of forefoot alignment. Instructions for constructing the device are provided. Use of this device may help clinicians evaluate forefoot alignment when making orthotic correction of the foot. [Glasoe WM, Allen MK and Ludewig PM (2002): Measuring forefoot alignment with a table-mounted goniometric device. Australian Journal of Physiotherapy 48: 51-53]

Key words: Forefoot, Human; Physical Examination; Range of Motion, Articular

Introduction

Orthoses prescribed to control excessive pronation commonly attempt to correct for the varus-aligned forefoot (Garbalosa et al 1994, Gross 1995). Forefoot varus is defined as a static deformity where the plane of the five metatarsal heads is fixed in a position of inversion in relation to the hindfoot when the subtalar joint is in a neutral position (Gross 1995). A varus-aligned forefoot is thought to diminish the ability of the first metatarsal to carry weight unless compensatory pronation occurs elsewhere in the foot (Garbalosa et al 1994, Johanson et al 1994). Gross (1995) postulates that an orthotic wedge placed beneath the medial forefoot improves ground contact of the varus-aligned forefoot, reducing the need for compensatory subtalar joint pronation. Supporting this premise, kinematic analysis has shown that the hindfoot and forefoot move independent of each other during gait (Lundberg et al 1989). Gait studies (Donatelli et al 1999, Hamill et al 1989), however, are less clear whether the static measure of forefoot alignment is a valid predictor of dynamic foot posture.

Forefoot alignment is measured in the clinic with a goniometer (Elveru et al 1988, Gross 1995, Johanson et al 1994, Somers et al 1997). The patient lies prone with the test foot overhanging the examination plinth (Gross 1995). From this position, the hands of the examiner palpate subtalar neutral and impose a dorsiflexing force to the lateral aspect of the forefoot. The examiner then measures alignment by placing the mobile arm of the goniometer against the plantar surface of the metatarsal heads while holding the goniometer's stationary arm perpendicular to a line bisecting the calcaneus. Because it is difficult to hold the foot and accurately align both arms of the goniometer, associated measurement error and concerns with reliability have been identified (Astrom and Arvidson 1995, Garbalosa et al 1994, Gross 1995).

A jig designed to quantify forefoot alignment has been marketed by the Langer Biomechanics Group (Garbalosa et al 1994) compared forefoot measures obtained with a standard goniometer with those made by this manufactured jig. Eighty-seven per cent of the 234 feet sampled had forefoot varus (mean = 7 degrees, range: 11 degrees valgus to 20 degrees varus), with the difference in goniometer versus jig mean values being less than 1 degree. Garbolosa and colleagues described the jig to be cumbersome to use requiring “constant adjustments” and recommended the goniometer as the better measurement tool. Astrom and Arvidson (1995) modified the goniometer method of measuring forefoot alignment by mounting a goniometric apparatus to the examination table. The apparatus held the goniometer in a position perpendicular to the calcaneus, freeing the examiner’s hands to control the foot and move the mobile arm of the goniometer. Astrom and Arvidson found the measure reliable with an intraclass correlation coefficient (ICC) of 0.92. Although endorsing use of a mounted goniometer as the easier methodology for measuring forefoot alignment; the apparatus they built was not adequately described for others to replicate. The purpose of this paper is to describe a table-mounted goniometric device built for the measurement of forefoot alignment.

Description of device

The device is assembled (Figure 1) with parts available from a hardware retailer at a cost of about $20. The skeleton of the device is constructed of wood: a 1cm × 9cm × 15cm faceplate, a 4cm × 4cm × 15cm cross-support, and a 2cm × 4cm × 30cm main-support. Screws hold the three-piece wood skeleton together. A 0.5cm × 15cm × 20cm piece of hardboard with a small centre slit rests upon the main-support. A 15mm No. 8 countersunk-head screw placed upside down (threads exposed) sits atop the main support with the threads of the screw protruding through the centre slit of the hardboard. This screw serves as the goniometer’s axis of rotation. A 16cm brass finished lid-support placed over the centre slit...
of the hardboard is screw-fastened to the wood skeleton. The open centred (opening of 0.5cm) lid-support permits movement of the goniometer separate from the device. Placing a 12-inch standard goniometer with the centre hole fitted around the overturned screw completes assembly. The device is attached to the end of the plinth by a hand squeeze-clamp. Attachment by clamp allows the device to be height-adjusted so the goniometer’s moveable arm approximates the plantar surface of the metatarsal heads for any sized foot (Figure 2).

**Measurement procedure**  The subject is positioned prone, the calcaneus aligned straight with the lower leg and placed parallel to the stationary arm of the device. Subtalar joint neutral is ascertained by palpating the congruency of the talus in the mortice joint (Gross 1995). As shown in Figure 2, a dorsiflexion force is then applied to the lateral metatarsals and the moveable arm of the goniometer is placed across the first and fifth metatarsal heads. The angle of forefoot inclination is recorded in relation to a plane perpendicular to the long axis of the lower leg (Astrom and Arvidson 1995, Gross 1995).

This device was used to measure forefoot alignment on 60 adult subjects in a previous study and the intra-rater reliability experiment was described (Glasoe et al 2000). The measure was reliable with an ICC of 0.95 and a standard error of measurement (SEM) of 1.5 degrees. The reliability coefficients found were higher than the ICC values (0.65 to 0.93) reported by others who measured forefoot alignment with jig (Astrom and Arvidson 1995, Garbalosa et al 1994) or goniometer (Diamond et al 1989, Elveru et al, Johanson et al 1994, Somers et al 1997). Due to the proportional variability of the ICC, it is helpful to consider the SEM value when interpreting reliability results. A between-trials SEM of 1.5 degrees computed in the previous study (Glasoe 2000) indicates that the goniometric device had a trial-to-trial average agreement better than 2 degrees. Inter-rater reliability of the device was not assessed. The intra-rater reliability coefficients recorded were from data collected on asymptomatic subjects, and could be different in a patient population. Additional research is needed.

**Summary**

Although the measurement of forefoot alignment is widely used in the clinic, its reliability has been questioned. A table-mounted device has been developed to simplify the measure of forefoot alignment. The device holds a standard goniometer, freeing the examiner’s hands during testing to control the foot and position the moveable arm of the goniometer. This inexpensive device improves the intra-rater reliability of measuring forefoot alignment. Clinical use of this device has potential to help quantify alignment of the forefoot.

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**Authors:** Ward Mylo Glasoe, Physiotherapy Associates 600 7th Street SE, Cedar Rapids IA 52401, USA. E-mail: ward.glasoe@physio.strykercorp.com (for correspondence). Mary Allen, Physiotherapy Associates, 600 7th Street SE, Cedar Rapids, IA 52401, USA. Paula Ludewig, Department of Physical Medicine and Rehabilitation Program in Physical Therapy, Box 388 Mayo, The University of Minnesota, Minneapolis, MN 55455, USA.

**Footnote:** (a)Langer Biomechanical Group, 21 E. Industry Ct. Deer Park, NY 11729-9986

**References**


