

The effect of posture on the osseous relations in the foot



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ABSTRACT

Background: Discrepancies observed between clinical findings and a weightbearing foot X-ray might be caused by a patients' positioning. This study's main objective was to determine the effect of a subjects' posture on the osseous relations of the foot.

Methods: Anatomical markers were placed on the skin of the foot of 17 subjects. A plantar pressure plate assessed the percentage weight on the foot and weight distribution over the foot. Medial longitudinal foot angles were derived from the markers and compared between the 10 postures. The effect of percentage weight and weight distribution on the foot angles was determined by multiple regression analysis.

Results: The foot angles were significantly affected by the postures. The multiple regression analysis revealed the weight on the foot and the mediolateral weight distribution over the foot as important factors for the foot angles.

Conclusion: A subjects posture significantly influences the osseous relations in the foot.

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1. Introduction

A basic orthopedic evaluation of the foot usually includes an anteroposterior (dorsoplantar) and lateral radiograph [1–7]. To provide an accurate reflection of the structural and functional nature of the foot, the X-ray is taken while the foot is weightbearing [1–3,6–12]. Often a discrepancy between clinical findings and the appearance of the foot on the X-ray is observed [13,14] a clinical apparent flexible pes planus can appear on an X-ray with a normal arch.

The first important aspect for an adequate radiograph is the position of the center of the X-ray beam, as well as the angle of the X-ray beam in relation to the foot [15,16]. Several studies demonstrated that standardizing these procedures, give reproducible results for radiographic foot measurements [9,17,18]. The standing posture of the subject is another factor. Standing posture influences the way the body weight is distributed between both feet and the force vector of the body working on each foot. Already in 1967 Hlavac demonstrated that positioning of the foot in

neutral, supinated, and pronated position alters the osseous relationships within the foot on radiographs [11,19]. Since then, other studies supported the importance of the posture and positioning of the foot [20–22]. X-rays are therefore often taken at the base of gait (midstance phase of gait) [2,11,12], in which the weight is about equally divided over both feet. However, a clinical observation at the radiology departments in multiple centers in the Netherlands showed that the posture of the patient was highly variable when radiographing the foot according to the already mentioned criteria. This could be a possible explanation for the discrepancy between clinical findings and the appearance on X-ray, which was also mentioned in the literature [16,23]. Therefore, the purpose of the present study was to evaluate the effect of standing posture on the osseous relationships of the foot.

2. Methods

2.1. Participants

A total of 17 subjects (13 women and four men) participated. Participants were randomly selected from the personnel working at our hospital ranging in age from 21 to 53 years (median 27). The median body weight was 73 kg (range 57–86 kg) and height was 177 cm (range 164–187 cm). The feet examined showed variation

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in anatomy and were considered functionally normal. None of the subjects had foot complaints, a history of foot surgery, rheumatoid arthritis, or neuromuscular problems. All participants provided written informed consent before participation.

2.2. Experimental setup

2.2.1. Anatomical landmarks

To avoid unnecessary radiation (a total of 24 radiographs), digital pictures were taken instead of radiographs. Anatomical landmarks were located by palpation and marked on the skin using a waterproof pen by a single researcher. To diminish the influence of skin motion, the markers were placed while the subjects were in a weightbearing standing position, with the knee in full extension. Four anatomical landmarks were identified at the medial side and three at the posterior side. The anatomical landmarks and their description are shown in Fig. 1.

2.2.2. Foot build registration system

Subjects were placed on the Foot Build Registration System (Research, Medical Physics and Biophysics, KVN, Nijmegen, The Netherlands), further referred to as FBRS (Fig. 1). The FBRS is a measurement system made to evaluate the foot in a standardized way [24,25].

2.2.3. Pressure plate

To evaluate the percentage weight on the foot and the distribution of pressure over the foot, a 0.5 m plantar pressure plate (RSscan, Olen, Belgium) was placed on top of the FBRS platform. In order to keep the feet of the participants in the standardized location we marked the mediolateral and the longitudinal line of the FBRS platform on the pressure plate.

2.3. Measurements

The participants were asked to step on the pressure plate and follow the instructions given by the experimenter. In total 10 postures were examined. The 10 postures were based on observations in clinical practice and were divided in five groups:

- First posture group: reference posture (RP) in which participants had an extended (RP_ext) or flexed knee (RP_flex).
- Second posture group: base of gait (BG) postures differed in the way the weight was distributed over the feet (BG_ipsi, BG_equal, BG_cont).
- Third posture group: Charlie Chaplin (CC): the participants were asked to place the contralateral foot in an angle of 90° to the foot to be examined and subjects had to put the most weight on the examined foot (CC_ipsi) or contralateral foot (CC_cont).
- Fourth posture group: medio-lateral (ML) in which the participants placed both feet next to each other on the mediolateral line to influence the mediolateral weight distribution over the examined foot (most weight on lateral part: ML_lat, most weight on medial: ML_med).
- Fifth group: Sitting (Sit) the participants had to sit and were asked to put minimal weight on the foot to be examined without lifting the foot off the pressure plate.

Detailed instructions regarding foot placement, weight distribution and knee angle for each posture, are described in Table 1.

For all postures a medial and posterior picture was taken except for the posterior picture of the sitting posture because the chair was blocking the camera frame. After the measurements of the ten postures, the participants were asked to step down from the FBRS and to step on it again. The foot was positioned in the same way

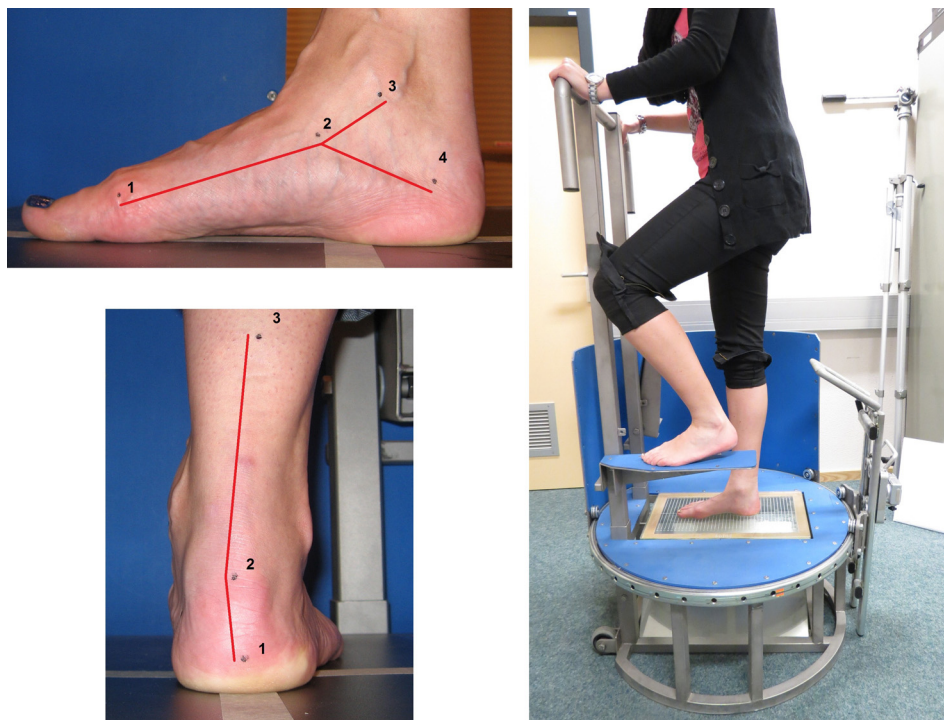


Fig. 1. Anatomical landmarks on the medial side (left panel) and posterior side (middle panel). The Foot Build Registration System (FBRS) is shown in the right panel. Medial view: 1 = Midpoint of the first metatarsal head, 2 = Midpoint of navicular tuberosity, 3 = Most distal border of the medial malleolus, 4 = Estimated midpoint of the dorsal part of the calcaneus. Posterior view: 1 = Midpoint of calcaneus, just proximal to fat pad, 2 = Midpoint calcaneus at insertion of Achilles tendon, 3 = Bisection of calf 15 cm above ground-level

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