

ORIGINAL ARTICLE / *Musculoskeletal imaging*

Correlation between primary flat foot and lower extremity rotational misalignment in adults

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KEYWORDS

Flatfoot;
Lower extremity;
Rotational deformity
of the lower limb

Abstract

Purpose: The goal of this study was to identify rotational abnormalities of the lower limb in adult patients with primary symptomatic flatfoot.

Materials and methods: From September 2009 to May 2012, 24 patients (12 women, 12 men; mean age: 40 years) were prospectively included in the study. Each patient underwent radiographs of the flat foot and weight-bearing upright EOS[®] examination. Three-dimensional reconstructions of the lower extremities were performed with derived measurements (length, hip and knee parameters, rotations). A total of 31 symptomatic primary flat feet (bilateral flat foot, $n=7$ patients; unilateral flat foot, $n=17$ patients) were studied and compared to 30 control subjects matched for age and gender. A comparison between the two groups was made with the Student t -test.

Results: No significant differences were found between patients and control subjects on the coronal and sagittal planes. Similarly, no significant differences were observed between the 2 groups for rotation of the lower limbs (femoral torsion, tibial torsion, tibiofemoral rotation).

Conclusion: There are no rotational abnormalities of the lower extremities in adult patients with primary symptomatic flat foot.

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Flat foot is characterized by a defect in the absorption mechanisms of the foot during walking. It includes several deformities that may be more or less severe such as collapse of the medial arch, hindfoot valgus and abduction and supination of the forefoot. Flat foot may be primary and more rarely secondary. It is frequent in children and adults, and is usually asymptomatic but may result in pain and/or muscle contractions causing the patient to consult a specialist. The diagnosis of flat foot is clinical. Weight-bearing radiographs confirm the diagnosis, determine the severity of the condition and are used to identify secondary degenerative damage. The physiopathogenic mechanisms of primary flat foot have not been determined. In children, primary flat foot may be associated with rotational abnormalities of the lower limbs [1]. In the adult, primary flat foot seems to be an isolated disorder, but this has not been confirmed.

EOS® (EOS Imaging, Paris, France) makes it possible to perform weight-bearing upright X-rays of the lower extremities with low doses of radiation as well as three-dimensional (3D) surface reconstructions of the lower limbs with more precise measurements derived from these reconstructions. Thus, lower limb rotational deformities can be reliably studied with the EOS® system [2–4].

The goal of our study was to evaluate rotational deformities of the lower limbs with the EOS® system in adult patients presenting with idiopathic symptomatic flat foot.

Patients and methods

This is a prospective, single center study that compared adult patients with primary flat foot and control subjects who were matched for age and gender. Patients and control subjects underwent a weight-bearing standing X-ray and an assessment of the lower extremities with the EOS® system.

Patients

From September 2009 to May 2012, 24 patients presenting with symptomatic primary flat foot were recruited by the orthopedic surgery department specialized in the foot and ankle. There were 12 men and 12 women, with a mean age of 40 years \pm 17.6 (SD) (range: 16–79 years). Seven of them presented with bilateral flat foot and 17 with unilateral flat foot. All patients had pain (perimalleolar pain or metatarsalgias) and/or a painful foot deformity. The patient's history, the clinical and podoscopic examination and baropodometry confirmed the diagnosis of flat foot, evaluated whether it could be reduced, excluded all causes of secondary flat foot and confirmed that the clinical symptoms were induced by primary flat foot. An additional radiographic evaluation was performed to quantify the severity of flat foot and evaluate its effect on bones and joints.

Control subjects

Control subjects were matched for age and gender to the patients. None of them presented with clinical or radiographic flat foot or static disorders of the lower limbs. There were 30 control subjects (16 men and 14 women) with a mean age of 40.6 years \pm 17.8 (SD) (range: 20–75 years).

X-rays

The radiographic evaluation included three weight-bearing views of the foot: an AP and lateral radiography and an AP view of the ankle with bimalleolar strapping (or a Meary view). The following measurements were obtained: angle of the summit of the medial arch (or Djian-Annonier angle) and talocalcaneal divergence on the lateral view of the foot (Fig. 1); calcaneal valgus on the Meary view (Fig. 2). In patients, the radiographic assessment was performed on the pathological side, unilaterally ($n=1$ patients) or bilaterally ($n=7$ patients). In control subjects, the radiographic assessment was performed unilaterally on the right or the left side, depending on the flat foot that it was matched with. In younger subjects, radiographic assessment was bilateral.

Weight-bearing standing EOS® of the lower limb

The entire lower limb was scanned with the EOS® system in coronal and sagittal planes simultaneously to further obtain 3D reconstructions of the surface of the lower limbs. During imaging the feet were placed 5 cm apart along a coronal plane, with the right foot in front, to individualize the femoral heads on 3D images. Native images were then transferred to a secondary workstation for post processing using specific software (SterEOS®) to obtain a 3D model of the tibial and femoral bone envelopes (Fig. 3). Post-treatment images were obtained by trained technicians in the

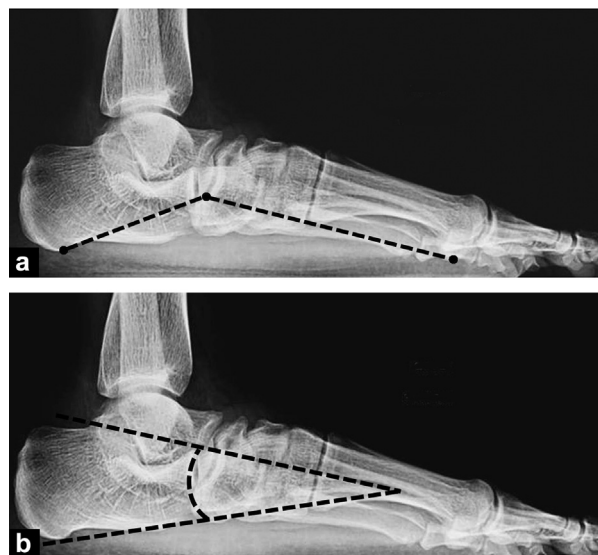


Figure 1. Measurement of Djian-Annonier and talocalcaneal divergence. A. Measurement of the Djian-Annonier angle in weight-bearing lateral radiograph of the foot. The angle is measured between the lowest point of the calcaneal tuberosity, the lowest point of the talonavicular joint and the lowest point of the medial sesamoid of the hallux. Normal values range from 120° to 130°. The Djian-Annonier angle is decreased in case of a flat foot. B. Measurement of talocalcaneal divergence in a weight-bearing lateral radiograph of the foot. Divergence corresponds to the angle formed by the major axis of the calcaneus and the major axis of the talus. Normal values ranged between 15° and 25°. Talocalcaneal divergence is increased in case of a flat foot.

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