

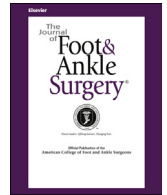


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Original Research

Relationship Between Grading With Magnetic Resonance Imaging and Radiographic Parameters in Posterior Tibial Tendon Dysfunction

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ABSTRACT

The objective of the present study was to elucidate the relationship between the state of the posterior tibial tendon (PTT) on magnetic resonance images and foot deformity. The cases included 34 feet in 27 patients with PTT deformity and the controls included 18 feet in 12 patients who had undergone magnetic resonance imaging for other foot diseases. The PTT was closely examined on the magnetic resonance images and classified using the Conti classification. The control feet with no injury to the PTT were classified as grade 0. The talonavicular coverage angle, lateral talo-first metatarsal angle, medial cuneiform to fifth metatarsal height, calcaneal pitch angle, and varus–valgus angle were measured as radiographic parameters for flatfoot deformation, and the relation between the Conti classification and each parameter was examined statistically. A significant difference was observed in the talonavicular coverage angle between grade 0 and the other grades; the lateral talo-first metatarsal angle between grade 0 and the other grades and between grades 1 and 3; the medial cuneiform to fifth metatarsal height among grades 0, 2, and 3 and grades 1, 2, and 3; the calcaneal pitch angle between grades 1 and 3; and the varus–valgus angle among grades 0, 2, and 3 and between grades 1 and 3. Eversion of the forefoot was observed, along with an advanced collapse in the medial longitudinal arch, from an early stage of PTT injury.

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Adult acquired flatfoot deformity is a condition in which either flatfoot deformity develops or progresses after the onset of middle age. In many cases, the cause of adult acquired flatfoot deformity is posterior tibial tendon (PTT) dysfunction (PTTD) accompanying a PTT injury. The function of the tibialis posterior muscle is to invert the foot, maintain a medial longitudinal arch, and maintain the hindfoot with respect to valgus deformation. These functions are lost in PTTD, aggravating flatfoot deformity (1,2).

Flatfoot deformity is characterized by the collapse of the medial longitudinal arch, abduction of the forefoot, and valgus of the hindfoot. The radiographic classification of PTTD includes an increase in the talonavicular coverage angle (TNCA), a parameter indicating forefoot

abduction (3,4), and an increase in the lateral talo-first metatarsal angle (LT1MA), a parameter indicating medial longitudinal arch (4). Furthermore, reports have demonstrated a decline in the medial cuneiform to fifth metatarsal height (C5MTH), a parameter indicating dropping of the medial longitudinal arch and forefoot supination (5–7), and in the calcaneal pitch angle (CPA), a parameter indicating a drop in the longitudinal arch (8). A special radiographic technique for the hindfoot is required to evaluate valgus owing to the overlapping of the shadow of the tarsal bones (e.g., metatarsal, cuneiform, navicular, and cuboid bones) with that of the calcaneus. The Cobey method (9), Saltzman method (10), and other methods that implement these techniques (11–13) were used to radiographically render the hindfoot; however, no parameter has been indicated for determining hindfoot valgus. We developed a new hindfoot radiographic technique and established the varus–valgus angle (VVA) as an angle to indicate the presence of hindfoot valgus (14).

Magnetic resonance imaging (MRI) has also been reported to be useful for investigating PTTD. Conti et al (15) classified their findings into 3 grades: grade 1, the tendon has become thicker and 1 high-signal

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Table 1
Subject characteristics stratified by group

Characteristics	PTTD Group	Control Group	<i>p</i> Value
Patients; feet (n)	27; 34	12; 18	NA
Gender (n)			NA
Male	3	3	
Female	24	10	
Laterality			NA
Right	14	11	
Left	20	8	
Age (yr)	67.9 ± 8.3	63.6 ± 8.5	.086
BMI (kg/m ²)	24.7 ± 3.2	23.0 ± 3.3	.065

Abbreviations: BMI, body mass index; NA, not applicable; PTTD, posterior tibial tendon dysfunction.

intensity area is observed; grade 2, the tendon has become thinner and several high-signal intensity areas and intramural degeneration are present; and grade 3, the continuity has disappeared and the sites in which the tendon exists have been replaced by high-signal intensity areas. However, only 1 case of grade 3 was reported by Conti et al (15), and few complete rupture cases were reported.

On the basis of the finding that the Conti classification would correspond to the degree of PTT injury and the radiographic parameters indicating deformation in PTTD, our hypothesis was a relationship might exist between the progression in flatfoot deformity accompanying PTT injury and the radiographic parameters of PTTD. The objective of the present study was to classify PTTD using the Conti classification on MRI scans and to clarify its correlation with each radiographic parameter.

Patients and Methods

The cases included 34 feet in 27 patients with painful PTTD (3 males and 24 females; 14 right and 20 left feet), who had undergone treatment at our institute from



Fig. 2. Lateral radiograph showing measurements of talo-first metatarsal angle (indicated by *a*), calcaneal pitch angle (indicated by *b*), and the height of the fifth metatarsal (indicated by *c*).

April 2008 to April 2015 (Table 1). The average patient age at the initial visit was 67.9 (range 49 to 80) years. The stage of PTTD using the Myerson classification was stage II in 30 feet and stage III in 4. The controls included 18 feet in 12 patients (3 males and 9 females) who had undergone MRI of the foot joint for other foot diseases, with an average age at the initial visit of 63.6 (range 49 to 78) years. The study was performed in accordance with the ethical standard of our institute (institutional review board approval no. ERB-C-324).

Radiographic Studies

With each subject standing, weightbearing anteroposterior (AP) and lateral radiographs were obtained in a standardized manner, with a cassette placed directly adjacent to the foot. For the AP images, the x-ray beam was located 100 cm from the subject's foot and angled 15° posteriorly toward the heel. The AP radiographs were examined for the AP TNCA, as described by Sangeorzan et al (3) (Fig. 1). The lateral



Fig. 1. Anteroposterior radiograph showing measurements of the talonavicular coverage angle (indicated by *a*).



Fig. 3. Varus-valgus angle: *a* indicates the top of the sustentaculum tali and *b*, the lateral-inferior end of the posterior facet of the calcaneus.

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