Radiographic Evaluation of Flatfoot in East Java Profesional Atlhete with Plantar fasciitis

Ratih Sulistyowati[a], Alfian Hasbi[a], Anandhika Dwijaya[a] , Rosy Setiawati[b*], Paulus Rahardjo[b]

*Corresponding author: drsetiarosy19@gmail.com
[a]Radiology Resident, Faculty of Medicine, Universitas Airlangga, Dr Soetomo General Academic Hospital, Surabaya 60286, Indonesia
[b]Radiology Consultant, Radiology Department, Faculty of Medicine, Universitas Airlangga, Dr Soetomo General Academic Hospital, Surabaya 60286, Indonesia

ABSTRACT

Objective: Weight resistance during exertion and overactivity in athletes is at risk of injury to the lower extremities and will decrease curvature of the plantar arch. With radiographs, we can perform initial imaging studies for evaluation of flat-foot, and there are several radiographic measurements that can indicate the degree of flat-foot deformity. Therefore, it is necessary to evaluate the radiographic measurements of the feet that can predict flat-foot in athletes with plantar fasciitis
Materials and Methods: The sample consisted of 112 samples from 56 athletes (n = 112) with complaints such as foot pain and from an ultrasound study proved to have plantar-fasciitis assuming a plantar-fascia approximately 4 mm. This is a descriptive observational retrospective study with cross sectional design. The study data consisted of the patient's medical records , ankle radiographic and plantar-fascia ultrasound study results which were collected through consecutive sampling. Foot arch type determined using radiographic ankle with calcaneal inclination angle and tarsal first metatarsal angle.
Results: After selecting the sample based on the inclusion and exclusion criteria, the number of samples was 112. Flat-foot was found in 75 sample (70,5 %) with calcaneal inclination angle, 54 sample (48,2%) have flat-foot and plantar-fasciitis. With talar fist metatarsal angle examination found 62 sample (55%) flatfoot, 39 sample (34,8%) have flat-foot and plantar-fasciitis
Conclusion: Flat-foot can be predicted by radiographic evaluation using calcaneal inclination angle and talar first metatarsal angle examination. Calcaneal inclination angle is considered more helpful to determine flatfoot than talar first metatarsal angle

Keywords: Flat-foot, Plantar-Fasciitis, Radiographic, Calcaneal inclination angle, Talar first metatarsal angle; Human & Health

1. Introduction

Flat foot is one of the common conditions experienced by about 20% to 30% of the world's population (Santoso, D., 2011). Flat foot also called pes planus or fallen arches is a condition where the arch of the foot is lost and is accompanied by pain (Giovanni, CD & Greishberg, J., 2007)

Flat foot can result from partial or complete loss of the arch of the foot (Pfeiffer, M., Kotz, R., Ledl, T., Hauser, G., & Sluga, M., 2006). Flat foot is classified into two types, namely congenital and acquired. Congenital consists of flexible flatfoot and rigid flat foot, while acquired flat foot is a complex disorder that occurs in adults with different symptoms and varying degrees of deformity (Wilson, M., 2008).

Flatfoot can develop due to weakening of the tendon of the tibialis posterior muscle, which is the main supporting structure of the arch of the foot. This condition leads to an even distribution of arches and twists in the ankle (Giovanni, CD & Greishberg, J., 2007)

Currently, radiography is the initial imaging study for flat-foot evaluation in which all radiographs are obtained in a weight-bearing position with standard techniques using the same digital radiography system. The calcaneal inclination angle provides the best assessment of injury to the supporting structures of the medial longitudinal arch (Lin, Y.C., Mhuircheartaigh, J. N., Lamb, J., Kung, J. W., Yablon, C. M., & Wu, J. S. 2015)

Symptoms of plantar fasciitis are pain in the heel and medial arch of the foot, which can be caused by a flat foot (Kaya, B. K., 1996). Condition of the flat arch of the foot by continuing to be active and practicing with a continuous frequency of exercise causes the sole of the foot to experience stress resulting in repeated microtrauma and inflammation due to excessive load on the longitudinal plantar fascia causing plantar fasciitis (Lim, A., How, C., & Tan, B., 2016)

This study aims to provide an overview of the evaluation of flatfoot with two radiographic methods of the ankle in athletes with plantar fasciitis

2. Materials and Methods

2.1 Study Design

This was a descriptive retrospective observational study with cross-sectional design that conducted at Dr. Soetomo General Academic Hosital Surabaya.

2.2 Ethical Clearance

This study was approved in Ethics Committee of Soetomo General Academic Hospital, Surabaya. All participants included in the samples had given their writen informed consent to participate in this study.

2.3 Subjects

The sample consisted of 112 sample from 56 athletes (n=112) than underwent foot radiographic examination in Radiology Department of Soetomo General Academic Hospital Surabaya. The participants were professional athletes at East Java Indonesia that have been chosen by national sport committee. The inclusion criteria were athlete with pain at ankle and foot, clinically support flatfoot images and had plantar-fasciitis. The exclusion criteria were history of flat foot that had previous surgical/non-surgical corrections, and there is fracture at ankle and foot.

2.4 Ultrasonographic and Radiological X-ray

The measurement of flatfoot that was use in this study was calcaneal inclination angle and talar-first metatarsal angle. Calcaneal inclination angle is Angle between the line at the plantar calcaneal surface and the horizontal plane with alignment angle <18° was considered as pes planus (Flores D v., Gómez CM, Hernando MF, Davis MA, Pathria MN. 2019)

Talar first metatarsal angle is an angle formed between the long axis of the talus and first metatarsal on a weight-bearing lateral view (Wilson, M., 2008) ,which alignment angle >4°, >15° and >30° was considered as mid, moderate and severe pes planus respectively (Flores D v., Gómez CM, Hernando MF, Davis MA, Pathria MN. 2019)

Real-time ultrasound imaging is one of the objective tools commonly used in the assessment of plantar fascia in many studies. Ultrasound is an accurate, reliable and non invasive imaging technique for assessing plantar fascia thickness (Mohseni-Bandpei, M. A., Nakhaee, M., Mousavi, M. E., Shakourirad, A., Safari, M. R., & Vahab Kashani, R., 2014)

3 Results

The study samples consist of 112 sample, which were divided into two, the angle of calcaneal inclination and talar first metatarsal angle was conducted with plantar fascia thickness ultrasound.

Table 1 show characteristics of samples and female were predominantly the most samples with 66 samples (58,9%) while male with 46 samples (41,1%) with range of age was 15 to 32 years old. Wrestling were predominantly samples with 34 samples (30,4%).

Table 1. Characteristics of samples

Characteristic		Total sample (n = 112)
Sex		
	Male	46 (41,1%)
	Female	66 (58,9%)
Age		
	Range	15 – 32
	Mean ± SD	21,68 ±3.89
Branch of sports		
	Fencing	26 (23,2%)
	Athletic	6 (5,4%)
	Wrestling	34 (30,4%)
	Handball	28 (25%)
	Gymnastic	4 (3.5%)
	Wushu	14 (12.5%)

Table 2 shows the results of the incidence of flat foot based on the calcaneal inclination angle as many as 79 of 112 samples (70.5%) while based on the talar first metatarsal angle as many as 62 of 112 samples (55.4%).

Table 2. Characteristics based on Calcaneal inclination angle and Talar first metatarsal angle

	Calcaneal Inclination Angle	Talar First Metatatarsal Angle
Flat foot	79 (70,5%)	62 (55.4%)
Normal	33 (29.5%)	50 (44.6%)

Highest incidence of flatfoot based on the calcaneal inclination angle, wrestling, which was 22 samples (19.6%) and based on the talar first metatarsal angle, fencing was 20 samples (17.9%). Meanwhile, the sport with the least incidence of flatfoot based on the calcaeal inclination angle was gymnastics as many as 4 samples (3.6%) and based on the talar first metatarsal angle was athletics as many as 2 samples (1.8%). This is shown in table 3

Table 3. Flatfoot frequency per sport based on calcaneal inclination angle and talar first metatarsal angle

Branch of sports	Calcaneal lnclination Angle		Talar First Metatarsal Angle	
	Flat foot	Normal	Flat foot	Normal
Fencing	20 (17,9%)	6 (5,4%)	20 (17,9%)	6 (5,4%)
Athletic	6 (5,4%)	0 (0%)	2 (1,8%)	4 (3,6%)
Wrestling	22 (19,6%)	12 (10,7%)	15 (13,4%)	19 (17,0%)
Handball	18 (16,1%)	10 (8,9%)	10 (8,9%)	18 (16,1%)
Gymnastic	4 (3,6%)	0 (0%)	4 (3,6%)	0 (0%)
Wushu	9 (8,0%)	5 (4,5%)	11 (9,8%)	3 (2,7%)
Total	79 (70.5%)	33 (29,5%)	62 (55,4%)	50 (44,6%)

4 Discussion

Flatfoot develops due to weakening of the tendon of the posterior tibialis muscle, which is the main supporting structure of the arch of the foot. This condition leads to an even distribution of arches and twists in the ankle (Giovanni, CD & Greishberg, J., 2007)

In determining the diagnosis of flatfoot, several x-ray radiographic measurements can be used. In our study we used the calcaneal tilt angle and the talar-first metatarsal angle, which according to Lin et al showed that radiographic measurements, especially the calcaneal pitch and Meary angle, are useful in detecting adult flatfoot. The calcaneal pitch angle or calcaneal tilt angle provides the best assessment of injury to the supporting structures of the medial longitudinal arch (Shibuya N, Kitterman RT, LaFontaine J, Jupiter DC., 2014; Lin YC, Mhuircheartaigh JN, Lamb J, Kung JW, Yablon CM, Wu JS., 2015), this is in accordance with our study where it was significantly more important to use the first metatarsal angle as a measurement than the calcaneal inclination angle.

In this study, samples were obtained with flat foot, there were 22 samples (19,6 %) from wrestling who experienced flat foot. According to research by Mosca in 2010 showed that increasing body weight will result in a shift in the center of gravity so that the distribution will focus on the center of the foot and the emphasis on the medial longitudinal arch supporting ligaments causes the subtalar and talonavicular joints to experience instability (Mosca V., 2010). Instability of the subtalar and talonavicular joints will result in eversion at the beginning of the gait phase, and inversion at the end of the gait phase. These eversions and inversions should not occur in a normal foot. This instability can initially be compensated by the intrinsic muscles of the foot, as a result the muscles

will work harder causing complaints in flexible flatfoot such as pain and fatigue when walking long distances, but in a long time these muscles are no longer able to compensate so that bone anatomy abnormalities (flat foot) (Mosca V., 2010)

Fencing athletes will spend a long time standing which can cause excessive injury to the feet and plantar fascia, in addition to standing for long periods of time biomechanically, the basic movements of fencing include ready movements, steps and attacks so that the center of gravity follows the direction of motion, the momentum of the object when it moves. When doing an attack movement, the body tends to move forward so that the load on the ankle and plantar fascia becomes more (Jannah, F.Z., Perdana, A., Nurhasanah, S., Suryano, N., Jutalo, Y.H. and Budi, A.S., 2014), this was found in our study where there is 20 samples (17.9%) who had flatfoot and plantar fasciitis.

Limitation of the study was the amount of the sample which are only limited variety type of sports, cannot distinguish whether flatfoot is congenital or acquired. Future studies with more samples and similar composition in gender are needed and furthermore, sample selection for more homogeneous population will minimize external factors.

5 Conclusion

Incidence of flatfoot common is wrestling(19,6 %) and fencing (17,9 %). Calcaneal inclination angle was considered more helpful (70,5%) to determine flatfoot than talar first metatarsal angle (55,4%).

Acknowledgement

The authors would like to thank Faculty of Medicine, Universitas Airlangga, Dr. Soetomo General Hospital and Radiology Department for supporting this study

Source of Funding

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for profit sectors

Conflict of Interest

Nil

Abbreviations :

FF **:** Flatfoot

References

Flores, D.V., Mejía Gómez, C., Fernández Hernando, M., Davis, M.A. and Pathria, M.N., 2019. Adult Acquired Flatfoot Deformity: Anatomy, Biomechanics, Staging, and Imaging Findings. RadioGraphics, 39(5), pp.1437-1460

Giovanni, CD & Greishberg, J. 2007. Foot and Ankle: Core Knowledge in Orthopaedics, Elsevier, USA

Jannah, F.Z., Perdana, A., Nurhasanah, S., Suryano, N., Jutalo, Y.H. and Budi, A.S., 2014, October. Analisis Biomekanika Dalam Gerakan Dasar Anggar. In Prosiding Seminar Nasional Fisika (E-Journal) (Vol. 3, pp. 121-124).

Kaya, B. K. 1996. Plantar Fasciitis in Athletes. Journal of Sport Rehabilitation, 5(4), 305–320. doi:10.1123/jsr.5.4.305

Lim, A., How, C., & Tan, B. 2016. Management of plantar fasciitis in the outpatient setting. Singapore Medical Journal, 57(04), 168–171. doi:10.11622/smedj.2016069

Lin YC, Mhuircheartaigh JN, Lamb J, Kung JW, Yablon CM, Wu JS. 2015. Imaging of adult flatfoot: Correlation of radiographic measurements with MRI. American Journal of Roentgenology. Feb 1;204(2):354–9.

Mohseni-Bandpei, M. A., Nakhaee, M., Mousavi, M. E., Shakourirad, A., Safari, M. R., & Vahab Kashani, R. 2014. Application of Ultrasound in the Assessment of Plantar Fascia in Patients With Plantar Fasciitis: A Systematic Review. Ultrasound in Medicine & Biology, 40(8), 1737–1754. doi:10.1016/j.ultrasmedbio.2014.03.001

Mosca V. 2010. Flexible tapak leper in children and adolescents.J Child Orthop;107–121.

Pfeiffer, M., Kotz, R., Ledl, T., Hauser, G., & Sluga, M. 2006. Prevalence of flat foot in preschool-aged children. Pediatrics, 118(2), 634–639. https://doi.org/10.1542/peds.2005-2126

Santoso, D. 2011. Perawatan Tepat Bagi Anda yang Memiliki Telapak Kaki Datar (Flat Feet).

Shibuya N, Kitterman RT, LaFontaine J, Jupiter DC. . 2014. Demographic, Physical, and Radiographic Factors Associated with Functional Flatfoot Deformity. Journal of Foot and Ankle Surgery;53(2):168–72.

Wilson, M. 2008. Synopsis of Causation Pes Planus. Dundee: Ninewells Hospital and Medical School.

Lin, Y.C., Mhuircheartaigh, J. N., Lamb, J., Kung, J. W., Yablon, C. M., & Wu, J. S. 2015. Imaging of Adult Flatfoot: Correlation of Radiographic Measurements With MRI. American Journal of Roentgenology, 204(2), 354–359. doi:10.2214/AJR.14.12645