ORIGINAL ARTICLE

MEAN THICKNESS OF PLANTAR FASCIA IN ASYMPTOMATIC LOCAL HEALTHY POPULATION USING HIGH RESOLUTION ULTRASOUND

Mina Mariam,[1] Muhammad Umar Amin,[2] Athar Ahmed,[3] Saima,[3] Yasrab[4]

[1]Department of Radiology, Shifa International Hospital, Islamabad, Pakistan.
[2]Department of Radiology, Quaid-e-Azam International Hospital, Islamabad, Pakistan.
[3]Department of Radiology, Dr. Akbar Niazi Teaching Hospital / Islamabad Medical and Dental College, Barakahu, Islamabad, Pakistan.
[4]Department of Radiology, KRL Hospital, Islamabad, Pakistan.

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ABSTRACT

OBJECTIVE: To determine the mean thickness of plantar fascia in asymptomatic local healthy population using high resolution ultrasound. **MATERIAL AND METHODS:** This descriptive cross sectional study was conducted at Radiology department, Shifa International Hospital, Islamabad (SIH). Duration of study was 6 months. Institutional review board approval was taken. A total of 150 volunteers were included from age group 18-40 years, 85 females and 65 males, healthy individuals. Thickness of plantar fascia was measured at 1 cm proximal to insertion of PF in sagittal plane by principal investigator and confirmed by consultant radiologist. Study was conducted at Toshiba Sonology machine with linear transducer, frequency of 5-7 Mega Hertz. **RESULTS:** Age range was 18-40 years, most patients presenting in age group of 18-28 years. Out of total 150 sample size there were 56 % females and 44% males. Mean thickness of PF with Standard deviation = 1.56 ± 0.54 mm. There is effect of weight, BMI, height, age and gender on thickness of PF. **CONCLUSION:** Mean thickness of PF in our study is within the normal limits of international available data, however is slightly towards the lower limit in both males and females. Mean thickness of plantar fascia is affected by age and gender of the individual. An interesting and statistically significant (p-value < 0.05) correlation was observed between gender, age and plantar fascia thickness.

Key words: Plantar fascia, mean thickness, weight, gender.

Introduction

Plantar fascia is a strong connective tissue extending from the os calcis to heads of second to fifth meta-tarsals of foot. It has three parts medial, lateral and central.[1,2] It acts as a major contributor of foot support i-e medial longitudinal arch and has shock absorbing function. It is directly exposed to stress during walking and daily activities.[2,3] The fascia has more chances of repeated injuries due to its role in maintaining medial longitudinal arch.[5] A number of pathologies of plantar fascia are commonly encountered of which plantar fasciitis is the most common and is considered most frequent cause of chronic plantar heel pain.[4] Plantar fasciitis is idiopathic and it is important to differentiate it from enthesopathy which is at times is part of seronegative arthropathy. Plantar fascial hypertrophy, tear, trauma, fibromas/fibromatosis and

Correspondence : Dr. Muhammad Umar Amin
Department of Radiology,
Quaid-e-Azam International Hospital,
Islamabad, Pakistan.
Email: umaramin71@gmail.com

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inflammatory changes of arthritic process are all important routine diagnosis.[2]

During the past years the popularity of ultrasound has increased in diagnosing plantar fasciitis. Sonological assessment of plantar fascia changes is excellent as it provides remarkable spatial resolution for superfiscial structures with added advantages of being cost effective, no radiation exposure, easy and well tolerated.[2,3]

In different studies thickness is measured at various sites and there is no standard location in this regard which results in difficulty in interpreting true results. Plantar fascia thickness greater than 4 mm is considered pathological.[3] In the proposed study thickness will be measured at 1 cm proximal to insertion point of plantar fascia in saggital plane as one of the reference points taken by Javier Pascal Huerta et al.[6] This location has shown very consistent results in this study and there is established relation of this location with gender of person and no relation to weight and age.

It is of basic importance to know the sonological / radiological landmark of where to measure the thickness of plantar fascia exactly as its thickness varies throughout its extent from proximal to distal.[6] However according to different studies there is agreement that 1 cm proximal to its insertion at calcaneum, consistent/ reproducible thickness is observed.

There is no local data available for our population and as our community has entirely different physical built from people in West due to differences of races, nutrition and lifestyle it is absolutely necessary to have data of our own region. Normal range of plantar fascia once documented locally would be highly useful for determining disease process at early stage as it will make clear range of normal lower and upper limit. Once a defined normal range is available it would be easier to compare differences in pre and post treatment values.

Material and Methods

SETTING: Radiology department of Shifa International Hospital (SIH) Islamabad. The study was conducted on healthy volunteers from Shifa college of medicine, nursing staff, colleagues and staff of Radiology department. The study was approved by ethical review board of SIH.

DURATION OF STUDY: For a total of 06 months.

SAMPLE SIZE: With help of WHO sample size calculator following is calculated
Confidence level=5%
Absolute precision required= 0.2
Population mean = 3.8[6]
Population S.D= 0.2
Sample size= 150 cases

Sampling technique: Non probability consecutive

Study design: Descriptive, cross sectional study
Sample selection:

Inclusion criteria: Age group 18-40 years, either gender asymptomatic healthy individuals.

Exclusion criteria: Individuals having congenital foot anomalies, history of foot surgery or arthritis. Previous surgery and arthritis related changes cause distortion of plantar fascia's normal anatomy.

Data collection: The study was started after seeking the approval of hospital research ethical committee. Written informed consent was taken from participants fulfilling the inclusion criteria. The aims, nature and procedures of the study were fully explained to the potential study population. A specially designed proforma, was filled to note the thickness of plantar fascia in right and left foot, age and gender of participant. Thickness of plantar fascia was measured at 1 cm proximal to its insertion at calcaneum in sagittal plane by principal investigator and was confirmed by consultant radiologist. Findings were recorded in the proforma.

Data analysis: Data was entered into SPSS 19 (IBM, USA). Mean and standard deviation were used for age and plantar thickness in right and left feet. Frequency and percentage were calculated for qualitative variables like gender. Effect modifiers like age and gender were controlled by stratification. Post-stratification chi-square test was applied keeping p-value less than or equal to 0.05 as significant.
Mean and Standard deviation were calculated for quantitative variables like age.

Results

The study included a total of 150 subjects of Pakistani origin in whom plantar fascia thickness was measured at 1 cm proximal to insertion in calcaneum by high resolution ultrasound. Study included 56 % females (N = 85) and 44% males (N= 65) Age range of all participants was between 18-40 years. Most participants were present in age range of 18-28 years. Frequency of male participants in this group was 60% and female participants had 74%. In the age group of 29-38 years frequency of males was 33% and females was 21%. In the next group 39-48 years, males were 6 % and females were 4.7% (Tab. 1).

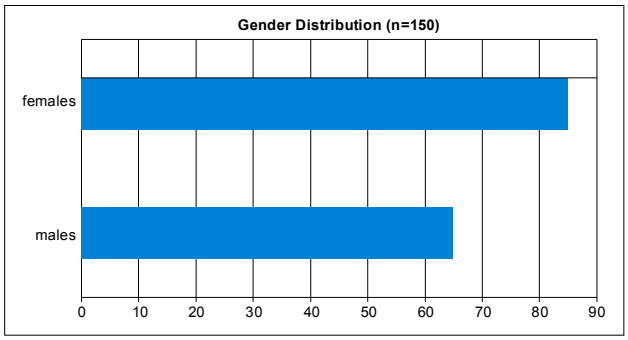

Table 1: Number of males and females in the population

Mean thickness of plantar fascia in our healthy male population came out to be1.99 mm for both feet with standard deviation of ± 0.45 (Tab. 2). Mean thickness of plantar fascia in our healthy female population came out to be 1.47 mm for left foot with standard deviation of ± 0.29. Mean thickness of plantar fascia in our healthy female population came out to be 1.53 mm for right foot with standard deviation of ±0.30. There is significant effect of age and gender on thickness of plantar fascia. Males have more thickness of plantar fascia as compared to females suggesting effect of gender on PF thickness (Tab. 3 and 4). With increase in age only minimal increase in thickness of PF was observed up to one decimal point (Tab. 5 and 6).

Gender	PF thickness in mm	N	Minimum	Maximum	Mean	Standard deviation
Male	Left foot	65	1.10	3.70	1.9954	.45909
	Right foot	65	1.30	3.40	1.9969	.45995
Female	Left foot	85	.80	2.50	1.4765	.29465
	Right foot	85	1.00	2.50	1.5318	.30245

Table 2: Mean thickness of plantar fascia in mm in males and females

Gender	PF Thickness	PF Thickness	PF Thickness	Total
	0.5-1.5mm	1.6-2.5mm	2.6-3.5mm	
MALE	8	49	8	65
FEMALE	55	30	0	85
	63	79	8	150

Chi-Square Test shows p < 0.01

Table 3: Effect of gender on thickness of plantar fascia (in mm) of right foot

Gender	PF Thickness	PF Thickness	PF Thickness	Total
	0.5-1.5mm	1.6-2.5mm	2.6-3.5mm	
MALE	6	56	3	65
FEMALE	55	30	0	85
	61	86	3	150

Chi-Square Test shows p < 0.01

Table 4: Effect of gender on thickness of plantar fascia (in mm) of left foot

Age Categories	PF Thickness	PF Thickness	PF Thickness	Total
	0.5-1.5mm	1.6-2.5mm	2.6-3.5mm	
18-28	52	46	4	102
29-38	11	25	4	40
39-48	0	8	0	8
TOTAL	63	79	8	150

Chi-Square Test shows p < 0.01

Table 5: Effect of age in years on thickness of plantar fascia (in mm) of right foot

Age Categories	PF Thickness	PF Thickness	PF Thickness	Total
	0.5-1.5mm	1.6-2.5mm	2.6-3.5mm	
18-28	52	49	1	102
29-38	9	29	2	40
39-48	0	8	0	8
TOTAL	61	86	3	150

Chi-Square Test shows p < 0.01

Table 6: Effect of age in years on thickness of plantar fascia (in mm) of left foot

Discussion

Chronic foot pain is one of the common complaints which bring patients to OPDs of orthopaedic sur-

geons, medical specialists, podiatrists and rheumatologists. There is a long list of differentials regarding this complaint. Plantar fasciitis is among the top most differential considering its prevalence. More than 2 million people seek medical advice for plantar fasciitis in united states.[3]

Plantar fasciitis is usually a clinical diagnosis, however above described various pathologies need to be ruled out as well. Conventional ultrasonography (USG) is a commonly used investigation in the initial evaluation and diagnosis of plantar fasciitis. It is employed due to inherent properties of USG being non invasive, quick, portable, requiring neither radiographic contrast media nor ionizing radiation and is relatively inexpensive. Developing countries like Pakistan have very limited resources in health sectors. Considering this USG is a cheap and widely available modality even in the peripheral areas of our country. People are much more aware of USG as diagnostic procedure as compared to MRI and are not reluctant for it. No patient preparation is required for USG. High resolution ultrasonography is particularly helpful in musculoskeletal system evaluation. It is latest technology which is continuously improving with better and better resolution complimented by colour and doppler USG fascilities. These colour and power doppler options are highly diagnostic in inflammatory conditions like plantar fasciitis as these show increased vascularity in plantar fascia when it is inflammed/swollen. High resolution USG is highly suitable for early evaluation of chronic heel pain. Radiographs of foot can help in determining the heel pad thickness but exact visualization of plantar fascia is possible either through USG or Magnetic resonance imaging (MRI). MRI is not the initial modality of choice as being expensive, time consuming and due to limited availability in developing countries like ours. It is only available in mega hospitals of few big cities in Pakistan. It is out of reach for maximum population of Pakistan. In monetary terms MRI is almost ten times more expensive than simple high resolution USG which decreases its popularity to considerable degree among physicians and patients. MRI has limitation for claustrophobic patients as well.

High resolution ultrasonography is cheap, non-invasive and very easy to perform radiological modality which renders it extremely suitable for preliminary evaluation of plantar fascia. It supports clinical evaluation by giving evidence of inflamed PF. It also helps in ruling out other major differential diagnosis. Many studies have shown significant thickening of PF in symptomatic patients when compared to asymptomatic foot.

Different studies have shown large variation in the mean thickness of PF in different populations. These mean values range from 2.9 - 6.2 mm in patients with plantar fasciitis and from 2.2 - 3.9 mm in asymptomatic healthy people.[6] Ozdemir et al., l showed mean thickness of PF to be 2.5 mm.[7] This variability makes it hard to compare our population thickness of PF with other populations as there is lack of standardization in this regard. There is also no consensus that at what exact location PF thickness should be measured from origin to insertion, however it is suggested by different studies that PF thickness at 1 cm proximal to insertion has shown relative consistency in results. As a general rule it is established that when the thickness of PF is greater than 4 mm it is considered as inflamed/pathological consistent with plantar fasciitis.[3] In a study conducted by Huerta et al., to measure thickness of PF in different locations in healthy asymptomatic individuals with 10 MHz linear transducer there was statistically significant difference in PF thickness between the four different measuring points from origin to insertion.[6] Factors like gender influence the thickness at 1 cm proximal to insertion of PF as described in our parent study by Huerta et al is supported by our current study too. However, thickness of PF at the origin and 1 cm distal to insertion are influenced by body weight. Our study has not included this point of origin of plantar fascia thickness and hence cannot be compared. This study has also shown moderate correlation between BMI and plantar fascia thickness which is confirmed as highly significant by our results as well with p-value of less than 0.01.[6] Another study performed by Uzel et al has shown moderate correlation between BMI and PF thickness.[8] Athletic activity also has influence on PF thickness, however this is beyond the scope for the current study. Additional study could be done regarding this topic which itself requires detailed evaluation.

Huerta et al., study also describes significant correlation between weight and thickness of plantar fascia at origin and 1 cm distal to origin.[6] In our study these

reference points of measurement are not taken but effect of weight is also shown at 1 cm proximal to insertion of plantar fascia with p value of less than 0.01. Plantar fascia is affected by over loading or heavy weight as described in various studies is further endorsed by our results also. In the study of Huerta et al.,[6] age was not significant factor to predict thickness of plantar fascia, however in our results it has p value of 0.002 suggesting it as a significant predictive factor. There is mild increase in thickness of plantar fascia with increase in age group by a decade as described in results table above. Although our study has limitation of assessing thickness of plantar fascia at only one point that is 1 cm proximal to insertion. The difference discussed above in results could be attributed to this difference. Height as independent predictive factor for the thickness of plantar fascia does not show statistical significance in the study performed by Huerta et al.,[6] however our results have shown it to be of contributing factor at the point 1 cm proximal to insertion with p value of less than 0.01. The primary goal in this study was acquiring basic knowledge of the normal PF thickness in our healthy local people. Association of different variables of age, weight, height, BMI and gender on PF thickness was also determined as secondary objective. This study was performed using high resolution USG. The participants in our study were basically studied using a Toshiba Xario USG machine. This study used 150 healthy volunteers in whom PF thickness of both feet were evaluated by myself as primary investigator. Findings were reviewed by my consultant/supervisor. The data from this study found that mean thickness of plantar fascia in our healthy male population came out to be1.99 mm for both feet with standard deviation of ± 0.45. Mean thickness of plantar fascia in our healthy female population came out to be 1.47 mm for left foot with standard deviation of ± 0.29. Mean thickness of plantar fascia in our healthy female population came out to be 1.53 mm for right foot with standard deviation of ± 0.30. Sex was a predictive factor of thickness of PF at 1 cm proximal to insertion. Males showed increase in thickness of 0.46-0.52 mm in PF as compared to females. These results are in consistency with the already published data from Europe and United States (as discussed above), however no local study was conducted on this topic in Pakistan or even in South Asia. Now we can be confident that what is the exact mean thickness of PF in our region and it is in agreement with data world over with only difference of being on slightly towards lower side of the international normal ranges available. Hence our goal is achieved in regard to establish our local values in measuring PF thickness. If one thing arises from these findings in comparison with other studies it is that regional or racial differences do exist between various populations in the parameter that we chose to assess. Therefore locally established data based on our population variation is important to serve as a benchmark in guiding local clinicians and diagnosticians. The local information infrastructure in our setting across the board must be established in many different facets. Values otherwise considered as the normal in other societies may not hold in our circumstances. This requires attention of clinicians and higher ups in research to address this issue on urgent basis as this may really improve the local data collection and publishing it will help clinicians and most of all patients themselves. Newer technologies that are becoming more easily available across the globe and new possibilities are opening locally to establish our own criteria and benchmarks. Therefore, this study sought to estimate the mean thickness of PF in local population.

Conclusion

Heel pain is one of the most common presentations in clinics and plantar fascial pathologies are the leading cause of this pain. High resolution USG has promising role in identifying these conditions specially plantar fasciitis. Mean thickness of PF in our study is within the normal limits of international available data, however is slightly towards the lower normal limits in both males and females. Mean thickness of plantar fascia is affected by age and gender of the individual as per results of current study. Males have more thickness of PF as compared to females.. Mild increase in thickness of PF is also noted with advancing age. An interesting and statistically significant (p-value < 0.01) correlation was observed between gender, age and plantar fascia thickness.

Conflict of Interest: None

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