

Ultrasound Evaluation of Normal Dimension of Plantar Fascia in Asymptomatic North Indian Population

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ABSTRACT

Objective: To evaluate the normal thickness of plantar fascia in asymptomatic North Indian population.

Material and methods: This was a prospective observational study where a cohort of 400 asymptomatic subjects were evaluated with ultrasonography for normal plantar fascia thickness. The subjects were kept in prone position and antero-posterior dimension of the plantar fascia was documented, approximately 5 mm distal to calcaneal insertion site. In addition, patient's gender, height, weight and BMI were also recorded. The data was then analyzed for any statistically significant association between the various patient related factors and plantar fascia thickness.

Results: Of the total 400 patients (800 feet) evaluated, 220 were females and 180 were males. The mean plantar fascia thickness in our study was $2.44 \text{ mm} \pm 0.60 \text{ mm}$, with mean thickness in males ($2.55 \text{ mm} \pm 0.60 \text{ mm}$) being greater than females ($2.35 \text{ mm} \pm 0.59 \text{ mm}$), with p-value of < 0.001 . No statistically significant difference was found between right ($2.45 \text{ mm} \pm 0.60 \text{ mm}$) and left feet ($2.43 \text{ mm} \pm 0.61 \text{ mm}$) with respect to plantar fascia thickness. Amongst the various patient related factors (age, height, weight and BMI), only age had significant effect on plantar fascia thickness on multivariate logistic regression analysis.

Conclusion: Ultrasound is an excellent non-invasive and easily available modality for evaluation of plantar fascia thickness.

Keywords: Plantar Fascia, Thickness, Sonography

INTRODUCTION

The plantar fascia is a fibrous aponeurosis arising from the medial calcaneal tuberosity and plays a significant role in the longitudinal arch support. Distal to the calcaneus, it continues anteriorly dividing into medial, central and lateral slips. The large central component adheres to the underlying flexor digitorum brevis muscle, and divides at the level of the mid-sole into five bands at the mid-metatarsal level. These further divide into deep and superficial components and course distally toward the toes, along with the medial and lateral marginal superficial tracts, with insertions onto each of the five proximal phalanges.^{1,2}

Plantar foot pain is one of the common complaints in the general population, with a high incidence of approximately 42% in older age group.³ Amongst multiple causes of plantar foot pain, plantar fasciitis is considered one of the commonest cause of heel pain. Clinically plantar fasciitis is diagnosed based on history and physical examination with characteristic pointing tenderness along antero-medial aspect of calcaneum, aggravated on dorsi-flexion.

Imaging plays a substantiating role in assessing the patients complaining of heel pain with MRI being the investigation of choice, which helps in assessing the morphological disarrangement in various pathologies of plantar fascia. However, ultrasound can also validate the diagnosis of plantar fasciitis and is cost effective, easily accessible modality for screening of patients with planter foot pain.⁴ Plantar fasciitis on ultrasound typically reveals increased thickness and reduced echotexture of plantar fascia.⁵ Although there have been many previous studies to evaluate the normal thickness of planter fascia and planter fasciitis on ultrasound^{6,7}, but most of them were conducted on population having a different demography, socio-economic status and lifestyle from our Indian sub-continent population. Thus, we undertook this study with the purpose of evaluating the normal plantar fascia thickness in asymptomatic North Indian population and its association with BMI amongst varying age group and gender.

MATERIAL AND METHODS

Our study was a prospective cohort study conducted in Government Medical College Srinagar from February 2018 to July 2019 with approval from ethical committee of the institution. The case cohort consisted of asymptomatic individuals having no history of heel pain while those individuals with positive ultrasound findings such as calcification, thickening and altered echogenicity of planter fascia were excluded from the study. Hence, the sample size comprised of 400 asymptomatic individuals among which 220 were females while the rest 180 were males.

The Ultrasound scan was performed in the radiology department by the radiology senior resident with GE Logic S8 Ultrasound Machine using 10-15 MHz linear array high frequency transducer. The patients were kept in the prone position and on sagittal plane, the antero-posterior dimensions of plantar fascia were taken, approximately 5 mm distal to its insertion onto the calcaneum. Additionally, patient's height, weight and BMI were also documented.

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	Mean (mm)	Standard Deviation (mm)	95% Confidence Interval (mm)	Range (mm)
Sample (n=800)	2.441	0.5997	2.358-2.524	1.4-3.5
Male (n=360)	2.554	0.5953	2.430-2.679	1.4-3.5
Female (n=440)	2.348	0.5898	2.237-2.460	1.4-3.5
Right Heel (n=400)	2.454	0.5952	2.336-2.572	1.4-3.5
Left Heel (n=400)	2.428	0.6069	2.307-2.549	1.4-3.5

Table-1: Plantar fascia thickness, 5 mm distal to calcaneal insertion

Pair Samples	Paired Differences					
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		P-value
				Lower	Upper	
Right PF-Left PF	0.2600	0.6296	0.06296	0.02849	0.03251	0.7600
Male PF-Female PF	-0.2467	0.5372	0.05663	-0.3594	-0.1340	< 0.0001

Table-2: Paired samples test

Predictors	R	p-value
Age group	0.139	<0.001
Sex	-0.214	<0.001
Weight	0.268	<0.001
Height	0.190	<0.001
BMI	0.191	<0.001

Table-3: Relationship of plantar fascia with age, sex, weight, height and BMI

Predictors	Beta coefficient	p-value
Age group	0.097	0.018
Sex	-0.75	0.142
Weight	0.309	0.456
Height	-0.030	0.912
BMI	-0.075	0.854

Table-4: Multivariate regression analysis

The data was analyzed using statistical software SPSS v 20 and STATA v 11. To assess significant differences in both the feet among male and female subjects, paired t- test was used. Categorical data was analyzed using Pearson's chi-square test. Quantitative data was analyzed using two sample independent t-test. A p-value less than 0.05 was considered as statistically significant.

RESULTS

Eight hundred (800) feet of four hundred (400) individuals were examined in the study. The study included 220 females and 180 males. The mean thickness of planter fascia at 5 mm distal to the calcaneal insertion was 2.44 mm \pm 0.60 mm (range, 1.4-3.5 mm and 95% CI, 2.36-2.52 mm). Among females, the mean planter fascia thickness was 2.35 mm \pm 0.59 mm (range, 1.4-3.5 mm and 95% CI, 2.24- 2.46 mm). While among males, the mean planter fascia thickness was 2.55 mm \pm 0.60 mm (range, 1.4-3.5 mm and 95% CI, 2.43-2.68 mm) (Table 1).

The difference was statistically significant, in which males were having higher mean plantar fascia thickness than females with p-value of < 0.001. The mean planter fascia thicknesses for the right and left feet were 2.45 mm \pm 0.60

mm (range, 1.4-3.5 mm) and 2.43 mm \pm 0.61 mm (range, 1.4-3.5 mm), respectively. This difference was not statistically significant (P value >0.05) (Table 2).

The results showed relatable effect of factors such as age, gender, weight, height and BMI on planter fascia thickness amongst subjects on univariate analysis, with p value < 0.05 (Table 3).

Variables that were significant on univariate analysis were then subjected to multivariate logistic regression analysis, and the results are summarized in Table 4

DISCUSSION

Plantar fascia is a strong fibrous aponeurotic tissue that arises from the medial calcaneal tuberosity and plays a major role in the longitudinal arch support of the foot.^{8,9,10,11} Plantar fascia is known to be affected with varying inflammatory (fasciitis), neoplastic (fibroma) and traumatic pathologies.^{12,13}

Amongst all, plantar fasciitis account for the most common etiology of heel pain.¹⁴ Although it is diagnosed clinically, but imaging modalities like Ultrasonography and MRI play a vital role in its diagnosis.¹⁵ MRI adequately illustrates the morphological and anatomical characteristics of plantar fascia with precise and definite assessment of pathological processes.¹⁶

From late 1970s, Ultrasonography has taken a big leap to evolve into a much improved technology permitting accurate illustration of normal anatomy and various pathologies, with good rate of sensitivity and specificity. Ultrasonography is also more readily available and is less expensive than MRI. Therefore, it has now become the first modality to evaluate plantar fasciitis.¹⁷

On ultrasound, plantar fasciitis presents with various appearances like hypoechoic echotexture, increased thickness, calcification within the substance of the fascia and associated surrounding fluid collection.^{5,12,18,19}

Color Doppler has also proved to be effective in validating diagnosis of plantar fasciitis by providing additional information regarding surrounding reactive inflammatory hyperemia.²⁰

Of all the above ultrasound features, the most consistent

finding noted in plantar fasciitis is increased thickness of the plantar fascia, which makes it an important parameter in the diagnosis of plantar fasciitis. Thus, the assessment of normal thickness of plantar fascia in general population becomes an important variable to be assessed.

In 2005, Osdemir et al²¹ conducted a study on 22 healthy volunteers and found the mean thickness of planter fascia to be 2.5 mm, measured at 5 mm distal to the calcaneal insertion site. In a similar study by Kamel M et al¹⁹, the final calculated mean plantar fascia thickness was 2.4 ± 0.64 mm, but they have not mentioned any specific landmark from which the dimensions were taken.

In one old study conducted by Cardinal et al⁵, the mean thickness of plantar fascia was $2.6 \text{ mm} \pm 1.13 \text{ mm}$ (ranging from 1.6 – 3.8 mm), measured at proximal insertion site of plantar fascia at calcaneum.

Significant differences were documented in a study conducted by Pascual et al⁷, when plantar fascia thickness was measured at four different sites (at 1 cm proximal to insertion, at insertion, 1 cm and 2 cm distal to calcaneal insertion site of plantar fascia). It was postulated by Pascual et al⁷ that the thickness of plantar fascia is more consistent along distal segment while it is quite variable at its proximal segment. At origin, plantar fascia margins are not oriented parallelly when compared to the distal segment, it is thus easy to assess its thickness at distal site. This led us to take the measurement at 5 mm distal to the insertion site of plantar fascia and achieve accurate measurements. Similar landmark for measuring the thickness of plantar fascia has been taken in various previously conducted studies evaluating the plantar fasciitis.^{21,22}

The mean plantar facial thickness calculated by Ozdemir et al²¹ and Kamel et al¹⁹ were almost similar to ours with mean thickness of 2.44 ± 0.60 mm. But when compared with the study of Uzel et al⁶ and Pascual et al⁷, the mean thickness was found to be much less.

One of the reasons for such variability in our study was due to the influence of different lifestyle, socio-economic status and geographic factor in our population and also in comparison to previous studies, our study was conducted on a much larger scale with sample size of 800 feet.

We conducted our study on asymptomatic healthy individuals, however, we feel that more studies should be conducted in our population including symptomatic individuals. This is because of the significant degree of variability observed in previously conducted studies by Wall et al²², Karabay et al²³ and Akfirat et al¹⁷ on symptomatic patients.

In our study, the mean plantar fascia thickness among females was less as compared to males with p-value < 0.001, which could be attributed to the anatomical difference among male and female subjects. Since in our daily routine both the feet are used equally, there was no significant statistical difference between left and right feet with p-value >0.05 in our study. Similar observations were made by Uzel et al⁶, however, in their study it was also concluded that there was moderate correlation between thickness of plantar fascia and individual factors like weight, height and BMI. Moderate

correlation between BMI and plantar fascia thickness was observed by Pascual et al in 2008.²⁴ In contrary to earlier studies, our results show only mild correlation between plantar fascia thickness and factors like age, gender, weight, height and BMI. However, weight was not observed to be a predictor of plantar fascia thickness in our study, in contrary to study of Pascual et al.⁷ This variability may be because most of our subjects were average weighted, with mean body weight in our study being 56 kgs.

CONCLUSION

The calculated mean plantar fascia thickness among asymptomatic individuals in our study was 2.44 ± 0.60 mm, thus giving a normalized range of plantar fascia thickness in North Indian population. Males were having significantly greater plantar fascia thickness than women.

There was only mild correlation between the thickness of plantar fascia and individual factors like age, weight, height and BMI. Plantar fascia thickness can be influenced by various biochemical stress factors for a longer duration of time, thus age influences to a great degree on plantar fascia thickness.

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