

High-resolution Ultrasonographic Diagnosis of Plantar Fasciitis: An Association of Magnetic Resonance Imaging and Ultrasound

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ABSTRACT

Objective: To assess the role played by ultrasound in evaluating plantar fasciitis and associate the findings with Magnetic resonance imaging.

Study Design: Case series.

Place and Duration of Study: Department of Radiology, Pakistan Institute of Medical Sciences, Islamabad Pakistan, from Nov 2020 to Apr 2021.

Methodology: All the patients underwent ultrasonography and magnetic resonance imaging scanning. The study and control Groups consisted of 38 patients.

Results: Out of 38 patients, plantar fascia thickness in symptomatic feet was measured with ultrasound for both the Study and Control Groups. The Control Group had slightly thinner plantar fasciitis ($1.1\text{-}2.4$ mm, 1.7 ± 0.06 mm; $p = 0.03$) compared to the Study Group ($2.9\text{-}6.9$ mm; 4.9 ± 1.4 mm). In addition, this study compared other plantar fasciitis diagnostic signs on sonography with the magnetic resonance imaging findings. The diagnostic accuracy of plantar fascia pathological focal echogenicity, plantar fascia oedema, perifascial oedema, and plantar fascia rupture was 15(80.6%), 12(60.7%), 15(77.1%), and 13(68.6%) respectively. The diagnostic accuracy of ultrasonography was lower while evaluating for calcaneal spurs.

Conclusion: The present study concluded that ultrasonography could be the basic initial diagnostic imaging modality to confirm clinically suspected cases of plantar fasciitis. However, magnetic resonance imaging could be the preferred diagnostic modality for suspected complex pathology and lack of clinical presentation.

Keywords: Magnetic Resonance Imaging, Plantar Fasciitis, Ultrasound.

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INTRODUCTION

Plantar fasciitis affects about 10% of the population, with approximately one million people treated each year.^{1,2} Plantar fasciitis is the fibrous tissue inflammation that causes intense heel pain along with the toes and connective heel position, accounting for 15% of sedentary adult cases.³ In this disease, histological variations in plantar fascia indicate fasciosis (degenerative process) rather than fasciitis (an inflammatory process), but fasciitis rests as the accepted classification of the disease process.⁴

Heel pain is a prevalent complaint in individuals with foot and ankle activities. Plantar fasciitis is considered one of the most prevalent sources of heel pain.⁴ Plantar fasciitis occurs mostly in females, middle-aged military recruits, athletes and obese individuals. About 10% of individuals have plantar fasciitis at any point during their lifespan, with the highest occurrences in middle age.⁵

Different imaging techniques, including basic scintigraphy, radiography, high-resolution ultrasonography,

and magnetic resonance imaging (MRI), have most recently been used to confirm plantar fasciitis diagnosis.^{6,7} A significant gain is the high spatial precision of sonography when faced with tiny lesions. Plantar fascia calcification, fibrillar pattern loss, collection of perifascial fluid, and increased thickness above 4 mm are the plantar fasciitis ultrasonography characteristics. Hyperemia in plantar fasciitis near perifascial soft tissue insertion proximity could be detected with Doppler ultrasound.^{8,9} However, magnetic resonance imaging is the most sensitive and accurate diagnostic modality for diagnosing plantar fasciitis.¹⁰

Numerous previous kinds of research conducted in Pakistan mainly focused on Musculoskeletal disorders, including back, shoulder and neck pain, while neglecting foot pain associated with plantar fasciitis with limited data available on preferred diagnostic imaging modality. Therefore, this study aimed to explore the role played by ultrasound in evaluating plantar fasciitis and associate the findings with Magnetic resonance imaging.

METHODOLOGY

The case series was conducted at the Department of Radiology, Pakistan Institute of Medical Sciences

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(PIMS), Islamabad Pakistan, from November 2020 to April 2021 after IERB approval.

Inclusion Criteria: Patients aged 25 to 59 years, with heel pain (acute or chronic) worse in the morning and tenderness along the medial calcaneal tuberosity, indicating plantar fasciitis, were included in the study.

Exclusion Criteria: Patients with a history of local inflammation, trauma, or heel surgery; any significant deformity or mass lesion that could prevent an accurate ultrasound or MRI examination; and patients with any MRI contraindication were excluded from the study.

All the patients underwent ultrasonography and MRI scanning. The Study and Control Groups consisted of 19 patients. Nineteen heels were found symptomatic, out of which seven were bilateral, and twelve were found unilateral. For past and current physical involvement in professions including overweight, Reiter’s disease, systemic lupus erythematosus, diabetes, prolonged weight-bearing, gout, psoriasis, rheumatoid arthritis, and ankylosing spondylitis sufferers were questioned and investigated. Both patients and the control Group were provided ultrasonography and magnetic resonance imaging. All ultrasound examinations were performed with a linear 5-17 MHz probe on Aplio 500. The thickness of plantar fascia was measured on the longitudinal view of the heel and confirmed on a transverse view. Even though each patient’s heels underwent examination, their history with bilateral complaints or similar was also examined. On ultrasound, the plantar fascia was uniform fibrillary structure measuring up to 4mm or less, whereas, in plantar fasciitis, the plantar fascia showed hypochoic thickening of more than 4mm, reduced echogenicity and occasionally perifascial fluid. All patients were assessed by MRI using a specific technique especially built for the analysis. Patients were placed with their feet in the supine position first and were instructed not to move during the test. Next, a foot MRI was performed using an extremity coil on a 1.5T Philips Gyroscan Achieva. The surface coil of the extremity was located over the surface of the foot. The plantar fascia’s thickness was measured in the sagittal plane.

The signal strength changes manifested as a hyper-intense signal in T2 fat sat and STIR images and/or intermediate signal in T1WI; fascial thickening exceeding 4 mm was reported and treated as diagnostic signs of plantar fasciitis. Other related findings to plantar fasciitis have been identified as perifascial oedema, oedema in adjacent soft tissues, underlying

calcaneal bone marrow oedema, and bony calcaneal spurs also been identified. Sonograms and MR images were analyzed blindly independently by trainee radiologists under the direct guidance of a specialized radiologist having significant experience in musculoskeletal ultrasound and MRI.

Statistical Package for Social Sciences (SPSS) version 22.0 was used for the data analysis. Quantitative variables were expressed as Mean±SD and qualitative variables were expressed as frequency and percentages. Independent sample t-test was applied to explore the inferential statistics. The *p*-value lower than or up to 0.05 was considered as significant.

RESULTS

Thirty-eight patients (19 of the study Group and 19 of the control Group) with plantar fasciitis were examined using ultrasonography and MRI. Plantar fascia thickness in symptomatic feet was measured with ultrasound for both the Study and Control Groups. The Control Group had slightly thinner plantar fascia (1.1-2.4mm; 1.7±0.06mm); *p*=0.02 compared to the study Group (2.9-6.9 mm; 4.9±1.4 mm). In addition, this study compared other plantar fasciitis diagnostic signs on sonography with the magnetic resonance imaging (MRI) findings. The diagnostic accuracy of plantar fascia pathological focal echo-genicity, plantar fascia oedema, perifascial oedema, and plantar fascia rupture was 15(80.6%), 12(60.7%), 15(77.1%), and 13 (68.6%) respectively. The diagnostic accuracy of ultrasonography was lower while evaluating for calcaneal spurs 11(56.5%).

The symptomatic foot plantar fascia’s thickness was (2.9–6.9mm, 4.9±1.4mm) and (2.4–6.8mm; 5.20±0.12mm) as obtained by ultrasound and MRI, respectively (Table-I). In addition, the result of the ultrasound of the symptomatic foot’s plantar fascia was found to be slightly thicker compared to that found in the control Group (1.1–2.4 mm; 1.7±0.06 mm); *p*=0.003 (Figure-1 & 2).

Table-I: Plantar Fascia Thickness Measured for Symptommatizing Using Magnetic Resonance Imaging and Ultrasound (n=38)

	Magnetic Resonance Imaging	Ultrasound
Control Group	2.1-2.8mm (2.6±0.05mm)	(1.1-2.4mm; 1.7±0.06mm)
Symptommatizing Group	2.4-6.8mm (5.20±0.12mm)	(2.9-6.9mm; 4.9±1.4mm)

Upon ultrasound review, abnormally low focal echogenicity was displayed by 19(82.6%) of the

symptomatic heels in the plantar fascia and high T2-weighted signal strength was shown after MRI examination in 18(77.1%) of the same Group in the



plantar fascia.
Figure-1: Sagittal Ultrasound of Plantar Fascia Analysis in a 40-year-old Male Patient Showing Thickened Planter Fascia of Symptomatic Heel 4mm

Figure-2: Sagittal Ultrasound of Plantar Fascia Analysis in a 36-year-old male Asymptomatic Patient Showing Normal Thickness of Planter Fascia of Asymptomatic heel 1.5mm

When considering MRI as a reference, 13(68.5%) was the ultrasound’s statistical diagnostic precision. In 12(63.2%) cases of MRI and 5(26.3%) of ultrasound, Edema was identified in the soft tissues of the symptomatic heels or around the plantar fascia. The ultrasound’s statistical diagnostic precision was 12 (59.8%), with the MRI, used as a reference, as shown in Table-II & III).

DISCUSSION



Our study reported plantar fascia thickness in plantar fasciitis of (2.9-6.9mm; 4.9±1.4mm) on ultrasound while 2.4-6.8mm (5.20±0.12mm) on MRI, which were within close range to the Ragab *et al.* 2011 and Gibbon *et al.* 1999 (3.0-7.0mm in range; 4.9±1.3mm).^{11,12}

However, McMillan *et al.* 2009 reported a higher value of plantar fasciitis thickness (2.9 mm mean±0.6 mm),¹³ (4.7 mm mean±1.5mm).¹⁴ This difference might be attributed to the higher proportion of obesity in their study, 47.8%, compared to our study, 27.9%. The control Group proximal plantar fascia thickness was (22.8mm in range; mean 2.4mm±0.07) measured by ultrasound, consisting of Lawrence *et al.* 2013 study.¹⁵ In our study, the frequent sonographic finding of the plantar fascia was hypoechoogenicity. The hypoechoogenicity percentage was 77.4%, close to 84% reported by another study.¹⁶

Table-II Varying Diagnostic Signs in Magnetic Resonance Imaging (MRI) and Ultrasound (n=38)

Signs	Ultra-sound	MRI	Positive (MRI and Ultrasound)	Negative (MRI and Ultrasound)
Focal Thickening	4	3	11	1
Abnormal Signal or echogenicity	3	3	11	2
Fluid Rupture	0	6	1	12
Fluid Collection	1	3	2	13
Subcutaneous Edema	1	7	3	8
Calcaneal spur	0	9	1	9

Table-III Diagnostic Precision of Ultrasound for Diagnostic Signs Comparing with Magnetic Resonance Imaging (n=38)

Variables	Diagnostic Accuracy
Intrinsic abnormal signal	68.5%
Focal thickening	71.1%
Fluid collection	77.2%
Subcutaneous edema	59.8%
Calcaneal spur	56.5%
Fiber rupture	68.5%

The inflammatory reaction could be caused by aponeurosis fibres undergoing repetitive trauma with micro-tear production.^{17,18} Our study found degenerative and repair patterns of collagen, micro tears, chondroid metaplasia, matrix calcification, and angiogenesis.^{19,20} In addition, the current study reported various phases of tissue injuries, such as chronic inflammation, fatigue, and inadequate healing.

MRI can differentiate plantar heel pain-causing parameters in plantar fasciitis. In addition, it can offer multi-planar capabilities, plantar fasciitis assessment in clinical value, particularly in sports medicine, and longitudinal parameters besides biopsy-guided images and injections.²¹

Planter fascia disorders are frequent causes of heel pain and ailment in the widespread population.

Diagnostic imaging is often essential to authenticate a diagnosis or disclose associated injuries. As a dynamic, inexpensive, fast imaging approach that also provides a high-resolution representation of the plantar fascia and comparison with the opposite side, ultrasound should be considered the investigation of choice for assessing Planter fascia disorders. MRI can accurately delineate both the soft tissue and bony anatomy of the foot and allow precise diagnosis of planter fascia disorders, but it is time consuming and expensive and should be regarded as a second-line imaging modality. Therefore, we come to an end with the idea that we should hold on to ultrasonography for evaluating plantar fascia since plantar fasciitis diagnosis done with sonography is useful as it provides justifiable diagnostic precision compared to magnetic resonance imaging unless complex pathologies are suspected.

LIMITATIONS OF STUDY

Most importantly, this study evaluated the association of ultrasound findings with MRI among heel pain and fascial thickness. However, other factors, such as the shape of an arch and regional loading of the foot at the univariate level and, as such, were not taken into scrutiny; hence it is unknown which, if any, of these variables is individually associated with heel pain.

CONCLUSION

The present study concluded that magnetic resonance imaging and ultrasound could accurately diagnose plantar fasciitis. Ultrasonography could be the basic initial diagnostic imaging modality to confirm clinically suspected cases of plantar fasciitis. Magnetic resonance imaging could be the preferred diagnostic imaging modality in suspected complex pathology and lack of clinical presentation.

Conflict of Interest: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

AK & AA: Data acquisition, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

IZ & MRB: Study design, drafting the manuscript, data interpretation, approval of the final version to be published.

MNNK & UA: Critical review, concept, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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