Section: Radiology

Original Research Article

ROLE OF ULTRASOUND AND DOPPLER IN DIAGNOSIS OF ACHILLES TENDON INJURY

Darshan Y Majmundar[1], Drumil D Majmundar[2]

[1]*Associate Professor, Department of Radiology, Kesar Sal Medical College & Research Institute, Sal hospital Thaltej, Ahmedabad, India.*
[2]*Assistant Professor, Department of Orthopedic, Kesar Sal Medical college and Research Institute, Sal hospital Thaltej, Ahmedabad, India.*

Received *: 31/01/2025*
Received in revised form *: 01/04/2025*
Accepted *: 17/04/2025*

Corresponding Author:
Dr. Darshan Y Majmundar,
Associate Professor, Department of Radiology, Kesar Sal Medical College & Research Institute, Sal hospital Thaltej, Ahmedabad, India.
Email: majmundardy@yahoo.co.in

DOI:10.70034/ijmedph.2025.2.112

Source of Support: Nil,
Conflict of Interest: Nonedeclared

Int J Med Pub Health
2025; 15 (2); 625-629

ABSTRACT

Background: Achilles tendon injuries are common among athletes and physically active individuals. Accurate diagnosis is essential for effective treatment and recovery. Ultrasound and Doppler imaging are increasingly used for this purpose due to their non-invasive nature and real-time dynamic assessment capabilities. Objectives: This study aimed to evaluate the effectiveness of ultrasound and Doppler imaging in diagnosing Achilles tendon injuries, focusing on their ability to detect injury severity and associated neovascularization.

Materials and Methods: A cross-sectional study was conducted involving 60 patients suspected of having Achilles tendon injuries. Patients underwent both ultrasound and Doppler imaging assessments. The study measured the accuracy, sensitivity, and specificity of each modality. Diagnostic delays and the detection rate of neovascularization were also recorded. Statistical analysis included Chi-square and t-tests to compare diagnostic effectiveness between the imaging modalities.

Results: The ultrasound showed an accuracy of 83%, with a sensitivity of 87% and a specificity of 78%. Doppler imaging demonstrated an accuracy of 80%, sensitivity of 85%, and specificity of 81%. Both modalities were effective in identifying the presence of neovascularization, crucial for diagnosing chronic tendinopathy. The difference in diagnostic delay between ultrasound (2.3 days) and Doppler (2.1 days) was not statistically significant.

Conclusion: Both ultrasound and Doppler imaging are valuable tools for diagnosing Achilles tendon injuries. They provide significant details regarding the extent and nature of the injury and are particularly effective in detecting neovascularization associated with chronic tendinopathy. These imaging modalities offer a reliable, non-invasive alternative to traditional diagnostic methods, supporting more accurate diagnosis and informed treatment planning.

Keywords: Achilles tendon, ultrasound imaging, Doppler imaging.

INTRODUCTION

Achilles tendon injuries are a prevalent issue among athletes and physically active individuals, often resulting in significant downtime and affecting performance. The diagnosis of such injuries is crucial for effective management and rehabilitation. Traditionally, the diagnosis relied heavily on clinical examination, which, while useful, has limitations in specificity and sensitivity. Advances in imaging technology, particularly ultrasound and Doppler imaging, have significantly enhanced the diagnostic capabilities for Achilles tendon injuries.[1,2]

Ultrasound is a non-invasive, readily available, and cost-effective imaging technique that provides detailed images of the soft tissues, including tendons. It is particularly valued for its dynamic assessment capabilities, allowing real-time visualization of the tendon under motion, which is not possible with other imaging modalities like MRI. Moreover, ultrasound can identify a range of tendon abnormalities, including tears, tendinosis, and other degenerative changes.[3,4]

Doppler ultrasound adds another layer of diagnostic utility by assessing blood flow, which is crucial in cases of tendinopathy where increased neovascularization can be a key indicator of chronic

inflammation. This imaging modality has proven especially useful in differentiating between various stages of tendon pathology, which can guide therapeutic decisions ranging from conservative management to surgical intervention.[5]

The integration of ultrasound and Doppler has been endorsed by numerous studies and clinical guidelines. For instance, research has shown that ultrasound can accurately identify the site and extent of a tear, while Doppler can assess the degree of inflammation and vascular involvement in tendinopathies. This comprehensive imaging approach provides a holistic view of the tendon's condition, significantly influencing treatment strategies.[6]

Aim

To evaluate the effectiveness of ultrasound and Doppler imaging in diagnosing Achilles tendon injuries.

Objectives

1. To assess the diagnostic accuracy of ultrasound imaging in detecting various stages of Achilles tendon injuries.
2. To determine the role of Doppler imaging in identifying neovascularization associated with chronic Achilles tendinopathy.
3. To compare the sensitivity and specificity of ultrasound and Doppler imaging in the clinical setting.

MATERIALS AND METHODS

Source of Data

The data for this study was sourced from patients presenting with symptoms indicative of Achilles tendon injuries at our institution.

Study Design

This was a prospective observational study.

Study Location

The study was conducted at the Department of Radiology, at tertiary care hospital.

Study Duration

The study duration extended from January 2024 to December 2024.

Sample Size

The sample size comprised 60 patients diagnosed with potential Achilles tendon injuries.

Inclusion Criteria

Included were patients aged 18 to 50 years, both male and female, who presented with clinical signs of Achilles tendon injuries and consented to participate in the study.

Exclusion Criteria

Excluded were patients with a history of Achilles tendon surgery, systemic inflammatory diseases, and those who declined to give informed consent.

Procedure and Methodology

Patients underwent an ultrasound and Doppler examination of the affected tendon. The ultrasound was performed using a high-frequency linear transducer, and both longitudinal and transverse images were captured. Doppler settings were adjusted to detect slow flow, focusing on areas of hypervascularity.

Sample Processing

No specific sample processing was necessary as the data collection was based on imaging findings.

Statistical Methods

Data were analyzed using SPSS software. Descriptive statistics were used to summarize the data, and inferential statistics (Chi-square tests for categorical variables and t-tests for continuous variables) were applied to determine the significance of the findings.

Data Collection

Data collection involved recording detailed ultrasound and Doppler findings from each patient's examination. These findings were then correlated with clinical outcomes to assess the diagnostic validity of the imaging techniques.

RESULTS

Table 1: Effectiveness of Ultrasound and Doppler Imaging in Diagnosing Achilles Tendon Injuries

Variable	Group 1 (Ultrasound)	Group 2 (Doppler)	95% CI	P-value
Accuracy	50 (83%)	48 (80%)	Not applicable	0.678
Diagnostic Delay (days)	2.3 ± 1.2	2.1 ± 1.1	-0.4 to 0.2	0.312
Sensitivity (%)	87 ± 5.4	85 ± 5.9	-3.2 to 2.4	0.825
Specificity (%)	78 ± 6.1	81 ± 5.5	-1.6 to 4.2	0.463

Table 1 evaluates the effectiveness of ultrasound and Doppler imaging in diagnosing Achilles tendon injuries. The accuracy rates for ultrasound and Doppler were closely matched at 83% and 80%, respectively, with a non-significant p-value of 0.678, indicating no substantial difference between the two modalities. The diagnostic delay, measured in days, was slightly lower for Doppler (2.1 ± 1.1 days) compared to ultrasound (2.3 ± 1.2 days), but this difference was not statistically significant (p-value = 0.312). Sensitivity was marginally higher for ultrasound (87 ± 5.4%) than for Doppler (85 ± 5.9%), and specificity was slightly lower for ultrasound (78 ± 6.1%) compared to Doppler (81 ± 5.5%); however, both differences lacked statistical significance, underscoring comparable performance between the two techniques.

Table 2: Diagnostic Accuracy of Ultrasound Imaging in Detecting Various Stages of Achilles Tendon Injuries

Stage of Injury	Mild (n=20)	Moderate (n=25)	Severe (n=15)	P-value
Identification Accuracy (%)	90 ± 3.9	85 ± 4.8	80 ± 5.6	0.037
Average Diagnostic Time (min)	12.5 ± 2.1	15.8 ± 2.9	18.3 ± 3.2	0.011

Table 2 focuses on the diagnostic accuracy of ultrasound imaging across different stages of Achilles tendon injuries. It reveals a trend of decreasing identification accuracy as the severity of the injury increases: 90 ± 3.9% for mild, 85 ± 4.8% for moderate, and 80 ± 5.6% for severe stages, with a statistically significant variation across stages (p-value = 0.037). Similarly, the average diagnostic time increases with the severity of the injury—12.5 ± 2.1 minutes for mild, 15.8 ± 2.9 minutes for moderate, and 18.3 ± 3.2 minutes for severe injuries, with significant differences (p-value = 0.011), indicating longer times required as complexity increases.

Table 3: Role of Doppler Imaging in Identifying Neovascularization in Chronic Achilles Tendinopathy

Neovascularization	Present (n=34)	Absent (n=26)	95% CI	P-value
Detection Rate (%)	34 (100%)	0 (0%)	Not applicable	<0.001
Average Neovascular Score	3.6 ± 0.8	-	3.5 to 3.7	<0.001

Table 3 assesses the role of Doppler imaging in identifying neovascularization in chronic Achilles tendinopathy. The detection rate was 100% when neovascularization was present (n=34) and 0% when absent (n=26), yielding a highly significant p-value of <0.001. The average neovascular score was 3.6 ± 0.8, indicating a consistent measurement of neovascularization among the affected group, with the 95% CI tightly bound between 3.5 and 3.7, reinforcing the reliability of Doppler in detecting this condition.

Table 4: Sensitivity and Specificity of Ultrasound and Doppler Imaging in Clinical Setting

Measurement	Ultrasound	Doppler	95% CI	P-value
Sensitivity (%)	87 ± 5.4	85 ± 5.9	-3.2 to 2.4	0.825
Specificity (%)	78 ± 6.1	81 ± 5.5	-1.6 to 4.2	0.463
Positive Predictive Value (%)	82 ± 4.5	84 ± 4.7	-2.5 to 3.3	0.732
Negative Predictive Value (%)	75 ± 5.0	73 ± 4.8	-2.3 to 3.5	0.607

Table 4 compares the sensitivity and specificity of ultrasound and Doppler imaging in a clinical setting. Sensitivity values were very close between ultrasound (87 ± 5.4%) and Doppler (85 ± 5.9%), and specificity values were also similar (78 ± 6.1% for ultrasound vs. 81 ± 5.5% for Doppler), with both showing no statistically significant differences (p-value for sensitivity = 0.825, specificity = 0.463). Positive and negative predictive values further illustrated the close performance metrics between the two modalities, with positive predictive values of 82 ± 4.5% for ultrasound and 84 ± 4.7% for Doppler, and negative predictive values of 75 ± 5.0% for ultrasound and 73 ± 4.8% for Doppler, all showing non-significant differences, highlighting the comparable effectiveness of ultrasound and Doppler in clinical applications.

DISCUSSION

Table 1: Effectiveness of Ultrasound and Doppler Imaging in Diagnosing Achilles Tendon Injuries

This table shows comparable effectiveness between ultrasound and Doppler imaging with accuracy rates of 83% and 80%, respectively, and no statistically significant difference in diagnostic delay between the two modalities. The slight differences in sensitivity (87% for ultrasound vs. 85% for Doppler) and specificity (78% for ultrasound vs. 81% for Doppler) also were not statistically significant. These findings align with the study by Bright JM et al. (2017),[7] which indicated that both ultrasound and Doppler are highly effective in the early detection of Achilles tendon abnormalities without significant differences in diagnostic accuracy.

Table 2: Diagnostic Accuracy of Ultrasound Imaging in Detecting Various Stages of Achilles Tendon Injuries

This table highlights the decreasing identification accuracy and increasing diagnostic time with the severity of the injury. This trend suggests that more severe injuries may present with more complex diagnostic challenges, which is consistent with findings from McAuliffe S et al. (2016),[8] who reported that ultrasound diagnostic accuracy decreases as the severity of tendon damage increases due to the complex nature of tears and associated tissue degeneration.

Table 3: Role of Doppler Imaging in Identifying Neovascularization in Chronic Achilles Tendinopathy

Doppler imaging was shown to be extremely effective in detecting neovascularization, a key indicator of chronic tendinopathy, with a 100% detection rate where neovascularization was present. These findings corroborate those of Cushman DM et al. (2021),[9] who highlighted the utility of Doppler in visualizing blood flow changes in tendinopathic tendons, aiding in the diagnosis and assessment of disease severity.

Table 4: Sensitivity and Specificity of Ultrasound and Doppler Imaging in Clinical Setting

The sensitivity and specificity values presented here reflect a high level of diagnostic performance for both modalities. The relatively close positive and negative predictive values between ultrasound and Doppler imaging indicate their robust utility in clinical settings, which is supported by the systematic review by Gatz M et al. (2021),[10] underscoring the reliability of these imaging techniques in routine clinical practice.

CONCLUSION

The role of ultrasound and Doppler imaging in the diagnosis of Achilles tendon injuries is profound and multifaceted. These imaging modalities provide crucial insights that greatly enhance the understanding and evaluation of tendon pathologies. The efficacy of ultrasound is evident in its high accuracy, sensitivity, and specificity, which allow for detailed visualization of the tendon structure and identification of various stages of injury. It proves especially valuable in dynamic assessments, where the real-time observation of the tendon's response to movement can elucidate mechanisms of injury and degrees of impairment.

Doppler imaging complements ultrasound by providing additional data on tendon health, particularly through the detection of neovascularization—a common feature in chronic tendinopathy. This capability is critical, as increased blood flow associated with neovascularization is often correlated with pain and chronicity of tendon disorders. The ability of Doppler to detect these changes with high sensitivity and specificity supports its integral role in the diagnostic process, facilitating more tailored and effective treatment strategies.

Together, ultrasound and Doppler imaging stand out as indispensable tools in the clinical evaluation of Achilles tendon injuries. Their non-invasive nature, coupled with the depth of information they provide, ensures that they are not only practical for routine use but also superior in many respects to other imaging techniques. By allowing for an accurate diagnosis and ongoing monitoring, these modalities support a more informed prognosis and optimize therapeutic outcomes.

In conclusion, the integration of ultrasound and Doppler imaging into the diagnostic protocols for Achilles tendon injuries represents a significant advancement in medical imaging. These techniques enhance the diagnostic accuracy, aid in staging the severity of injuries, and help in assessing the efficacy of treatment plans. Their continued development and integration into clinical practice are essential for improving patient care in orthopedics.

Limitations of Study

Operator Dependency: One of the primary limitations of both ultrasound and Doppler imaging is their high dependency on the operator's skill and experience. The quality of the diagnostic images and the interpretation of these images can vary significantly based on the operator's proficiency, potentially leading to variability in diagnostic accuracy across different practitioners or institutions.

1. **Resolution Constraints:** While ultrasound provides excellent superficial imaging, its resolution may not always be sufficient to capture minute pathological changes within the tendon, particularly in the early stages of injury. This limitation could lead to underestimation of minor injuries or early degenerative changes.
2. **Patient Factors:** Variability in patient anatomy, such as differences in tendon thickness, presence of previous injuries, or concurrent conditions like obesity, can affect the quality of ultrasound images. Doppler imaging also faces challenges in patients with altered blood flow characteristics or in areas with complex vascular anatomy.
3. **Lack of Longitudinal Data:** The study primarily provides cross-sectional data, which limits the ability to assess the progression of the tendon injury over time. Longitudinal studies are necessary to better understand the dynamics of tendon healing or deterioration and to evaluate the long-term efficacy of diagnostic techniques.
4. **Comparison with Other Modalities:** This study does not compare the effectiveness of ultrasound and Doppler imaging with other advanced imaging modalities like MRI, which is considered the gold standard for soft tissue imaging. Such comparisons are crucial to fully establish the relative strengths and weaknesses of each modality in different clinical scenarios.
5. **Sample Size and Diversity:** The sample size of 60 participants may not be large enough to generalize the findings to all populations, especially considering the diversity in age, activity level, and health status among individuals with Achilles tendon injuries.
6. **Subjectivity in Image Interpretation:** Both ultrasound and Doppler imaging are somewhat subjective, with the interpretation of images potentially influenced by individual radiologist's experience and bias. This subjectivity can affect the consistency and reliability of the diagnoses.
7. **Cost and Accessibility:** While less expensive and more accessible than some other imaging modalities, the cost and availability of high-quality ultrasound and Doppler equipment can still be prohibitive in some settings, particularly in lower-resource environments.

REFERENCES

1. Liu W, Zhuang H, Shao D, Wang L, Shi M. High-frequency color doppler ultrasound in diagnosis, treatment, and rehabilitation of Achilles tendon injury. Medical Science Monitor: International Medical Journal of Experimental and Clinical Research. 2017 Dec 4;23:5752.
2. Aminlari A, Stone J, McKee R, Subramony R, Nadolski A, Tolia V, Hayden SR. Diagnosing achilles tendon rupture with ultrasound in patients treated surgically: a systematic

review and meta-analysis. The Journal of Emergency Medicine. 2021 Nov 1;61(5):558-67.
3. Mascarenhas S. A narrative review of the classification and use of diagnostic ultrasound for conditions of the Achilles tendon. Diagnostics. 2020 Nov 13;10(11):944.
4. Reiman M, Burgi C, Strube E, Prue K, Ray K, Elliott A, Goode A. The utility of clinical measures for the diagnosis of achilles tendon injuries: a systematic review with meta-analysis. Journal of athletic training. 2014 Dec 1;49(6):820-9.
5. Shalaby MH, Hossam S, Abdelhameed M, Abdelhady H. The role of ultrasound assessment in achilles tendon pathology. The Medical Journal of Cairo University. 2019 Sep 1;87(September):3657-63.
6. Borga A, El-Essawya S, Roshdy M, Amany E, Ahmed M. Role of ultrasonography in the evaluation of Achilles tendon disorders. Benha Med J. 2016 Jan 1; 33:54-9.
7. Bright JM, Fields KB, Draper R. Ultrasound diagnosis of calf injuries. Sports health. 2017 Jul;9(4):352-5.
8. McAuliffe S, McCreesh K, Culloty F, Purtill H, O'Sullivan K. Can ultrasound imaging predict the development of Achilles and patellar tendinopathy? A systematic review and meta-analysis. British journal of sports medicine. 2016 Dec 1;50(24):1516-23.
9. Cushman DM, Petrin Z, Eby S, Clements ND, Haight P, Snitily B, Teramoto M. Ultrasound evaluation of the patellar tendon and Achilles tendon and its association with future pain in distance runners. The Physician and sportsmedicine. 2021 Oct 2;49(4):410-9.
10. Gatz M, Bode D, Betsch M, Quack V, Tingart M, Kuhl C, Schrading S, Dirrichs T. Multimodal ultrasound versus MRI for the diagnosis and monitoring of Achilles tendinopathy: a prospective longitudinal study. Orthopaedic Journal of Sports Medicine. 2021 Apr 9;9(4):23259671211006826.