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Diagnostic Accuracy of the Royal London Hospital Test and Painful Arc Test in The Diagnosis of Achilles Tendinopathy

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ABSTRACT: Achilles tendinopathy (AT) is a common musculoskeletal disorder characterized by pain and functional impairment. The Royal London Hospital Test (RLHT) and Painful Arc Test are non-invasive physical examinations for detecting AT. However, the use of these two diagnostic tools in Indonesia remains limited. This study aims to evaluating the diagnostic accuracy of the RLHT and Painful Arc Test for diagnosing AT. This cross-sectional diagnostic study involved individuals with Achilles tendon pain who met the study criteria. Subjects underwent the RLHT and Painful Arc tests by independent examiners, with ultrasonography as the reference standard. Analysis included sensitivity, specificity, negative predictive value, positive predictive value, and overall accuracy. A total of 44 subjects were enrolled; based on ultrasonography, 30 subjects (68.2%) were diagnosed with AT and 14 subjects (31.8%) were normal or non-AT. The RLHT demonstrated a sensitivity of 86.67% and a specificity of 57.14%, with an overall accuracy of 77.3%, while the Painful Arc Test demonstrated a sensitivity of 90.00% and a specificity of 57.14%, with an overall accuracy of 79.5%. In conclusion, the RLHT and the Painful Arc Test demonstrated high sensitivity, supporting their use as screening tools for Achilles tendinopathy

1. INTRODUCTION

Achilles tendinopathy (AT) is among the most prevalent musculoskeletal issues affecting both the general populace and athletes, especially in those exposed to significant mechanical stress, including runners, jumpers, badminton players, and military people. The ailment is marked by degenerative changes in the Achilles tendon due to overexertion or recurrent microtrauma, resulting in discomfort, inflammation, and compromised biomechanical performance.^{1,2}

The total occurrence of AT is approximated at 1.85 instances per 1,000 individuals, with an elevated rate of 2.35 instances per 1,000 among those aged 21 to 60. The incidence of AT varies between 9.1% and 10.9% among active runners, while the lifetime risk for former elite male long-distance runners surpasses 50%. Epidemiological information regarding the frequency of AT in Indonesia is scarce; yet, a noticeable increase in cases is apparent among active groups, particularly amateur runners engaged in the growing trend of mass-participation running events.^{1,3}

An appropriate therapeutic approach is contingent upon an accurate diagnosis in clinical evaluation. Physical examinations, including the Royal London Hospital Test (RLHT) and the Painful Arc test, are frequently implemented due to their practicality and non-invasiveness.⁴ Reiman et al. (2014) reported that the RLHT has a sensitivity of 54% and a specificity of 86% in diagnosing AT.⁵ Meanwhile, Maffulli et al. (2020) reported that the painful arc has a sensitivity of 52.5% and a specificity of 83.3% in diagnosing AT.⁶ Nevertheless, the diagnostic accuracy differs among studies. Additionally, the diagnostic accuracy of this test for AT in Indonesia has not yet been evaluated in any studies, and its use is not yet prevalent in the country. Accurate

early-stage diagnosis of AT can alleviate the socio-economic consequences of tendinopathy, enhance the quality of life of patients, decrease the likelihood of tendon rupture, and expedite the return of athletes to sports.^{3,7,8} The objective of this investigation is to ascertain the diagnostic efficacy of the RLHT and painful arc in the diagnosis of Achilles tendinopathy.

2. MATERIALS AND METHODS

2.1 Study Design

This diagnostic accuracy study employs a cross-sectional design and is being conducted from March 2025 to July 2026 at Hasanuddin University Teaching Hospital. The study population consists of patients with suspected Achilles tendinopathy who are undergoing RLHT and painful arch examinations, alongside ultrasound as the reference standard.

2.2 Participants

This study employed purposive sampling. The inclusion criteria were as follows: 1) patients aged ≥ 18 years; 2) presence of Achilles tendon pain; and 3) ability to walk and perform activities independently. The exclusion criteria were as follows: 1) lower extremity disorders, or systemic, vascular, or joint diseases affecting the musculoskeletal system (e.g., rheumatoid arthritis, gout, collagen disorders); 2) pregnancy; 3) skin disease or wounds in the Achilles tendon area; and 4) use of analgesics from two days prior to data collection up to the time of data collection.

2.3 Ethical Clearance

The Ethics Committee of the Faculty of Medicine, Hasanuddin University, and Hasanuddin University Teaching Hospital granted ethical approval and authorization for this study. The objectives and procedures of the study were disclosed to all study subjects, who subsequently signed an informed consent form to indicate their willingness to participate. The publication of the study results with the subjects' identities anonymized was consented to by all participants.

2.4 Assessment and Inspection Techniques

Royal London Hospital Test

The RLHT is a clinical examination that involves palpating the Achilles tendon's area of maximum tenderness while the ankle is in a neutral position or minor plantar flexion. This is followed by re-palpation during maximal dorsiflexion. The test is deemed positive if tenderness substantially decreases or disappears during maximal dorsiflexion, and negative if tenderness does not decrease.

Painful Arc

The painful arc is a clinical test that is designed to evaluate the movement of an area of intratendinous thickening or swelling during active ankle dorsiflexion and plantar flexion. The test is positive if the intratendinous thickening area moves with the tendon relative to the malleolus during ankle movement, and negative if the thickening area does not move with the tendon.

Ultrasound Examination to Diagnose AT

The Achilles tendon structure is evaluated in longitudinal and transverse planes using B-mode and Doppler musculoskeletal ultrasound at 2 cm proximal to the calcaneal tuberosity (insertional Achilles tendinopathy) and 6 cm proximal to the calcaneal tuberosity (midportion Achilles tendinopathy). The assessed findings include hypoechoic areas, loss of the normal fibrillar pattern, cross-sectional area (CSA), and tendon thickening or variations in thickness (specifically, an increase in the anterior-posterior diameter exceeding 50% compared to the asymptomatic contralateral side). The diagnosis is categorized by the ultrasound examiner as either Achilles tendinopathy or non-Achilles tendinopathy.

2.5 Data Analysis

All collected data were entered into Microsoft Excel and Statistical Package for the Social Sciences (SPSS) version 29.00. Subject characteristics—including sex, body weight, height, body mass index (BMI), comorbidities, diagnosis (based on ultrasound results), and the side of the foot affected by AT were assessed. Numerical variables such as body weight, height, and BMI are presented as mean and standard deviation, whereas categorical variables such as sex, comorbidities, diagnosis, and the side of the foot affected by AT are presented as frequencies and percentages. The diagnostic accuracy parameters evaluated in this study, such as sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and overall accuracy were calculated manually. The formulas used for these calculations are as follows:

- a) Sensitivity: $\text{true positive} / (\text{true positive} + \text{false negative})$
- b) Specificity: $\text{true negative} / (\text{true negative} + \text{false positive})$
- c) NPV: $\text{true negative} / (\text{true negative} + \text{false negative})$
- d) PPV: $\text{true positive} / (\text{true positive} + \text{false positive})$

e) Overall accuracy: (true positive + true negative) / all subjects

The 95% CI for diagnostic accuracy was determined manually using the Wald method in Microsoft Excel. The associations between RLHT assessment and ultrasound, as well as between painful arc assessment and ultrasound, were evaluated using Fisher's exact test. A 95% confidence level was used, and a p-value <0.05 was considered significant.

3. RESULTS AND DISCUSSION

3.1 Subject Characteristics

This study involved 44 subjects who met the inclusion and exclusion criteria. Subject characteristics were assessed based on gender, body weight, height, BMI, comorbidities, diagnosis (based on ultrasound results), and the side of the foot affected by AT. Subject characteristics are presented in **Table 1**. Women predominated in this study compared to men (52.3% vs. 47.7%), with a mean age of 37.95 ± 11.74 years, body weight of 67.55 ± 13.70 kg, height of 162.09 ± 8.88 cm, and BMI of 26.74 ± 8.55 . Thirty-seven subjects (84.1%) had no comorbidities, while seven subjects (15.9%) had comorbidities such as hypertension, diabetes mellitus, and asthma. Thirty subjects were diagnosed with TA based on ultrasound results, while 14 subjects (31.8%) were normal or did not have TA. Regarding the affected side, 13 subjects (29.5%) had symptoms on the left side, 15 subjects (34.1%) on the right side, and 16 subjects (36.4%) had bilateral symptoms.

For subjects with bilateral symptoms, one side was designated as the index side for diagnostic analysis; thus, the unit of analysis remained the subject, and the total number of observations in the diagnostic accuracy analysis was 44. Regarding pain onset, four subjects (9.1%) had an onset of less than 1 month, 35 subjects (79.5%) had an onset ranging from 1 to 6 months, and five subjects (11.4%) had pain lasting longer than 6 months. Based on the Numeric Rating Scale (NRS) assessment, the mean NRS score among the study subjects was 3.52 ± 1.70 , indicating that pain levels in this group tended to be low. A greater number of subjects engaged in exercise compared to those who did not (29 subjects [65.9%] vs. 15 subjects [34.1%]).

Table 1. Characteristics of the research subjects

Characteristics	Frequency (n=44)	Percentage (%)
Gender		
Men	21	47.7
Women	23	52.3
Age	37.95 ± 11.74	
Weight	67.55 ± 13.70	
Height	162.09 ± 8.88	
BMI	26.74 ± 8.55	
Comorbid		
Yes	7	15.9
No	37	84.1
Diagnosis		
AT	30	68.2
Non-AT	14	31.8
Side of the foot		
Left	13	29.5
Right	15	34.1

Characteristics	Frequency (n=44)	Percentage (%)
Bilateral	16	36.4
Onset of Pain		
<1 Month	4	9.1
1-6 Months	35	79.5
>6 Months	5	11.4
NRS	3.52±1.70	
Exercise/Sport		
Yes	29	65.9
No	15	34.1

3.2 Diagnostic Accuracy of RLHT for AT Diagnosis

Table 2 presents the results of the RLHT and ultrasound examinations. Among the subjects who tested positive on the RLHT, 26 (81.3%) were confirmed to have AT based on ultrasound findings, while the remaining 6 (18.8%) did not. Among those who tested negative on the RLHT, 4 (33.3%) were diagnosed with AT via ultrasound, while the other 8 (66.7%) did not have AT. A significant association was observed between RLHT results and the ultrasound-based diagnosis of TA (OR = 0.115, 95% CI [0.026–0.513], $p = 0.004$). The RLHT demonstrated a sensitivity of 86.67% (95%CI 69.28-96.24) for diagnosing AT, with a specificity of 57.14% (95%CI 28.86-82.34), PPV of 81.25% (95%CI 63.56-92.79), NPV of 66.67% (95%CI 34.89-90.08), and overall accuracy of 77.27% (95%CI 62.16-88.53). These results indicate that the RLHT has relatively high sensitivity in identifying subjects with AT, whereas its specificity in identifying subjects without AT is lower. The relatively high PPV suggests that the majority of positive test results represent true AT cases, while the lower NPV indicates limitations in using a negative test result to rule out a AT diagnosis.

Table 2 Distribution of Royal London Hospital Test Results Based on TA Diagnosis, Using Ultrasonography as the Reference Standard

Royal London	Diagnosis (ultrasound)		Total	p-value	OR (95CI% lower-upper)
	AT	Non-AT			
Positive	26 (81.3%)	6 (18.8%)	32 (72.7%)		
Negative	4 (33.3%)	8 (66.7%)	12 (27.3%)		
Total	30 (100%)	14 (100%)	44 (100%)	0.004*	0.115 [0.026-0.513]

*Fisher's Exact Test

3.3 Diagnostic accuracy of the painful arc for the diagnosis of AT

Table 3 presents the results of the painful arc test and ultrasound examination. Among subjects who tested positive on the painful arc test, 27 (81.8%) were confirmed to have AT based on ultrasound findings, while the remaining 6 (18.2%) did not. Among those who tested negative on the painful arc test, 3 (27.3%) were diagnosed with AT via ultrasound, while the other 8 (72.7%) did not have AT. A significant association was found between the painful arc test results and the ultrasound diagnosis (OR = 0.083, 95% CI [0.017–0.411], $p = 0.002$). The sensitivity of the painful arc test for diagnosing TA was 90.00% (95%CI 73.47-97.89) with a specificity of 57.14% (95%CI 28.86-82.34), PPV of 81.82% (95%CI 64.54-93.02), NPV of 72.73% (95%CI 39.03-93.98) and overall accuracy of 79.55% (95%CI 64.70-90.20). These results indicate that the painful arc test has high sensitivity in identifying subjects with AT, whereas its specificity is relatively lower in identifying subjects without AT. The

relatively high PPV suggests that the majority of positive test results represent true AT cases, while the lower NPV indicates that a negative test result still has limitations in definitively ruling out a AT diagnosis.

Table 3 Distribution of Painful Arc Test Results Based on Rotator Cuff Tear Diagnosis Using Ultrasonography as the Reference Standard

Painful Arc	Diagnosis (ultrasound)		Total	p-value	OR (95CI% lower-upper)
	AT	Non-AT			
Positive	27 (81.8%)	6 (18.2%)	33 (75%)		
Negative	3 (27.3%)	8 (72.7%)	11 (25%)		
Total	30 (68.2%)	14 (31.8%)	44 (100%)	0.002*	0.083 [0.017-0.411]

*Fisher's Exact Test

3.4 Discussion

Ultrasound is a routine diagnostic tool for AT. Nevertheless, it has significant disadvantages in comparison to RLHT, such as the necessity for costly apparatus and operator dependence, whereas RLHT is free and directly assesses functional pain. The diagnosis of AT can be facilitated by RLHT.⁶ A fibrillar echotexture with parallel hyperechoic lines is observed in the long-axis (LAX) view of a normal Achilles tendon on ultrasound, as per the literature. The tendon presents a homogeneous hyperechoic appearance and a reniform (kidney-shaped) contour in the short-axis (SAX) view. A normal Achilles tendon thickness ranges from 4 to 6 millimeters.⁹ The mid-portion of the Achilles tendon in healthy individuals has a mean thickness of 4.9 mm (range: 3.0–6.9 mm), according to Visser et al. (2024). The thickness at the tendon insertion is 3.7 mm (range: 2.8–4.8 mm).¹⁰ Typically, a cross-sectional area (CSA) of 0.4 to 0.6 cm² (40 to 60 mm²) is recorded for a normal adult Achilles tendon when measured by ultrasound.^{10,11}

The findings of this investigation suggest that RLHT has an accuracy of 77.27%, a specificity of 57.14%, and a sensitivity of 86.67% in the diagnosis of AT. These results indicate that the RLHT employed in this study is capable of accurately identifying individuals with TA, despite its relatively limited capacity to differentiate between those without AT. In other words, the RLHT is more effective as a screening tool within this study population than as a standalone diagnostic test. Currently, there are no established guidelines for the development of a "gold standard" test for the diagnosis of AT.⁸

The sensitivity value of 86.67% suggests that the majority of subjects diagnosed with AT via ultrasound had a positive RLHT result. Nevertheless, the sensitivity confidence interval of 69.28–96.24% indicates that this estimate is subject to uncertainty. Consequently, the 86.67% figure is a point estimate that was derived from the study sample and should not be considered the definitive sensitivity value for the population of interest. In contrast, the specificity estimate is less precise, as evidenced by the comparatively wide interval of 57.14% (95% CI: 28.86–82.34%). This may be due to the fact that the number of subjects without AT is significantly lower than that of those with the condition (14 versus 30). AT was diagnosed in 30 of the 44 subjects in the study, while the remaining 14 were classified as the non-tendinopathy group based on ultrasound findings.

The high sensitivity of the findings is demonstrated in the RLHT examination technique, which indicates a positive AT result by local pain upon palpation of the tendon with the ankle in a neutral position or slightly plantar-flexed. The pain disappears completely or significantly when the ankle is dorsiflexed.⁶ This implies that the patient's pain response significantly impacts the results of this examination. Additionally, the Royal London Hospital test and ultrasound yield distinct results; the former evaluates pain, while the latter focuses on structural modifications. The characteristic pain pattern associated with the RLHT is not necessarily the consequence of structural changes in the tendon observed via ultrasound, and the reverse is also true.⁹ Therefore, the sensitivity of the RLHT does not reach 100% when compared to ultrasound.

The results of this study are in contrast to those of numerous previous studies, including the research conducted by Matthews et al. (2026), which investigated the diagnostic accuracy of clinical examinations for AT patients. In contrast to the results of the current study, the RLHT demonstrated a sensitivity of 59.0% and a specificity of 83.0% in that investigation.¹² The RLHT was reported to have a sensitivity of 54.2% and a specificity of 91.2% in a study conducted by Maffulli et al. (2003), which also

examined the diagnostic accuracy of clinical examinations for AT.¹³ Although structural changes or mild degeneration in the Achilles tendon do not always result in pain (remaining asymptomatic), they can be identified through imaging examinations, such as ultrasound. This is corroborated by a study conducted by Lieberthal et al. (2019), which demonstrated that nearly half (46%) of the asymptomatic long-distance runners in their study possessed at least one anomalous tendon.¹⁴ This can lead to false negatives in the RLHT, resulting in low sensitivity for the test.

A comprehensive analysis by Matthew et al. (2021) has validated this, indicating that the RLHT demonstrates sensitivity and specificity that differ among studies; specifically, a sensitivity of about 51–54% and a specificity of 91–93% in comparison to ultrasound.⁸ The variations in sensitivity and specificity can be comprehended via the operational mechanism of the RLHT. This assessment is conducted by locating the area of greatest sensitivity on the Achilles tendon with the ankle in a neutral or slightly plantar-flexed stance, thereafter re-palpating when the patient engages in vigorous dorsiflexion. The RLHT is deemed affirmative if the sensitivity at that location markedly diminishes following maximal dorsiflexion.^{6,15} Consequently, this examination may be affected by multiple conditions associated with Achilles tendon discomfort, such as retrocalcaneal bursitis, complete or partial Achilles tendon rupture, tarsal tunnel syndrome, and posterior tibial tendon rupture, which act as differential diagnoses for Achilles tendinopathy and can produce a positive RLHT outcome.⁸ This element elucidates why the findings of this research indicate that the RLHT possesses a negative predictive value of 66.67% and a positive predictive value of 81.25%.

The diagnostic accuracy of the Painful Arc sign in diagnosing AT is also assessed in this study. The Painful Arc can assist in the differentiation of tendon and paratenon lesions. In paratendinopathy, the area of maximal tenderness and thickening remains in a fixed position relative to the malleolus from dorsiflexion to maximal plantar flexion, while a lesion within the tendon moves with ankle motion. The tenderness associated with discrete nodules is frequently observed; however, it diminishes or vanishes when the tendon is subjected to tension.⁶ A sensitivity of 90.00% indicates that the majority of subjects with ultrasound-confirmed AT yielded a positive Painful Arc result. However, the 95% confidence interval of 73.47–97.89% suggests that this sensitivity estimate is subject to uncertainty. Conversely, the specificity of 57.14% (95% CI: 28.86–82.34%) presents a wider interval, indicating relatively lower precision in the specificity estimate. This warrants particular attention, given that the study included only 14 subjects without AT, compared to 30 subjects with ultrasound-confirmed tendinopathy. A sensitivity of 90.00% indicates that the majority of subjects with ultrasound-confirmed AT yielded a positive Painful Arc result. However, the 95% confidence interval of 73.47–97.89% suggests that this sensitivity estimate is subject to uncertainty. Conversely, the specificity of 57.14% (95% CI: 28.86–82.34%) presents a wider interval, indicating relatively lower precision in the specificity estimate. This warrants particular attention, given that the study included only 14 subjects without AT, compared to 30 subjects with ultrasound-confirmed AT.

The findings of this investigation suggest that the Painful Arc test has an accuracy of 79.55%, a specificity of 57.14%, and a sensitivity of 90% in the diagnosis of AT. These results are distinct from those of prior research, including the study conducted by Matthew et al. (2026) on the diagnostic accuracy of clinical examinations for TA patients. The results of the present study are in stark contrast to those of the previous study, which reported a sensitivity of 41% and a specificity of 100% for the Painful Arc test.⁸ A systematic review by Reiman et al. (2014) shows that the Painful Arc has a sensitivity of 42% and a specificity of 88%.⁵ Hutchison et al. (2013) conducted a systematic review to determine the most effective clinical tests for AT. The Painful Arc test was found to have variable sensitivity and specificity. According to the review, the most reliable tests for AT are subjective reports of pain 2–6 cm proximal to the calcaneal insertion (sensitivity 78%, specificity 77%), and pain upon tendon palpation (sensitivity 84%, specificity 73%).⁷ The primary objective of the Painful Arc test is to evaluate the mobility of the distended tendon area as a symptom of intratendinous structural involvement, rather than to evaluate pain provocation during movement.^{5,7} These influencing factors resulted in the Painful Arc test demonstrating an NPV of 72.73% and a PPV of 81.82%, as well as differences in sensitivity and specificity compared to other studies. Variations in results across studies may be attributed to differences in subject characteristics, the disease spectrum, the location and severity of tendon changes, and variations in the standardization of examination techniques. The Painful Arc test is known to be primarily associated with the movement of the thickened mid-portion of the Achilles tendon; therefore, the distribution of lesion locations within the study population can also influence its diagnostic performance. The relatively low specificity observed in this study indicates the presence of a number of false-positive results. However, the precise cause of these false-positive results cannot be determined based solely on the data from this study. Therefore, the results of the Painful Arc test should be interpreted in conjunction with the patient's history, other physical examination findings, and relevant ancillary tests, rather than being used as a standalone test to establish a diagnosis of AT.

3.5. Limitation

This study has several limitations that should be considered when interpreting the results. First, the number of study subjects was relatively small; consequently, estimates of sensitivity, specificity, PPV, NPV, and accuracy may be subject to wide confidence intervals and limited precision. Second, the use of purposive sampling could introduce selection bias and limit the generalizability of the findings. All subjects were individuals complaining of pain in the Achilles tendon region; thus, the sample characteristics may not fully represent the entire spectrum of patients encountered in clinical practice. Most subjects presented with relatively low pain levels and long-standing or chronic symptoms, meaning their responses to clinical examinations might differ from those of patients with more severe pain or those in acute or subacute phases. These conditions could influence the subjects' clinical spectrum and limit the generalizability of the results across all phases of Achilles tendon pathology. Third, the clinical examinations were performed by more than one examiner. Although all examiners were Physical Medicine and Rehabilitation residents with similar educational backgrounds who had undergone training and procedural standardization prior to the study, variations in palpation techniques, the interpretation of pain responses, and the observation of clinical findings remained possible. The influence of these examiner-related factors was not specifically analyzed in this study.

Fourth, certain subject characteristics, such as symptom duration, pain intensity, age, physical activity level, and the specific location of tendon involvement, could potentially influence the results of the RLHT and Painful Arc tests. However, these factors were not further analyzed regarding their impact on the diagnostic performance of each test.

Fifth, the specificity of the RLHT and Painful Arc tests observed in this study was lower than that reported in some previous studies. This may be attributed to the characteristics of the study population, as all subjects presented with pain in the Achilles tendon region; consequently, some subjects who showed no signs of tendinopathy on ultrasound imaging could still exhibit positive clinical examination results. Furthermore, the discrepancy between clinical manifestations and structural tendon changes observed on ultrasound may also contribute to false-positive results.

Nevertheless, this study remains valuable, as research on the diagnostic accuracy of RLHT and the Painful Arc test for diagnosing AT is still relatively limited, particularly within the local population.

4. CONCLUSION

The RLHT and painful arc can be employed as components of a comprehensive clinical examination; however, they cannot be considered the sole basis for establishing an AT diagnosis.

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AUTHOR CONTRIBUTIONS

DAA, AS, and HM determined the research topic. DAA searched for and processed the data and drafted the article. AS, HM, AAZ, NM, and NS provided supervision.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are not available

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