

The Role of Ultrasound Investigation in Acute Achilles Tendon Rupture

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ABSTRACT

Objectives: This study aims to investigate the reliability of ultrasound in differentiating between partial and complete TA ruptures. It also aims to establish whether ultrasound findings of TA ruptures are in accordance with intraoperative findings.

Method: The authors identified all cases of Achilles tendon rupture treated operatively in a unit over the course of the year. Charts were reviewed retrospectively to identify whether cases had undergone ultrasound. Intraoperative findings and ultrasound reports were compared.

Results: 49 cases of Achilles tendon rupture were diagnosed and treated operatively. 23 cases underwent ultrasound of the tendoachilles preoperatively. 8 were reported as partial ruptures. All cases were found to be complete rupture intraoperatively. The sensitivity of ultrasound in establishing completeness of tendoachilles rupture is 63.5%.

Conclusion: Ultrasound differentiation of complete vs partial ruptures is not a useful differentiator.

Keywords: Achilles tendon, tendon repair, tendon rupture, ultrasound.

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1. INTRODUCTION

The Achilles tendon is formed by the convergence of both the soleus and gastrocnemius muscles as it inserts onto the posterior aspect of the calcaneus (Aminlari *et al.*, 2021; Hess, 2010; Järvinen *et al.*, 2005). The tendon spans three separate joints and contributes to knee flexion, foot plantar flexion, and foot inversion (Egger & Berkowitz, 2017).

One of the most common pathologies that may affect the Achilles tendon is an Achilles tendon rupture (TA rupture). It is regarded as the most common tendon pathology in the lower extremity and most commonly occurs in adults, often in their third to fifth decade of life (Elias & McKinnon, 2011; Holm *et al.*, 2015). The injury often occurs as a result of indirect trauma to the tendon resulting from sports or exercise. Additionally, pre-existing conditions and certain drugs, such as fluoroquinolones and steroid injections, have been linked to an increased risk of rupture (Egger & Berkowitz, 2017).

Achilles tendon ruptures may be categorized as ‘complete rupture’ in which all the fibers of the tendon have been separated, or ‘partial rupture’ in which there is still some degree of continuity in the fibers and only a portion of the tendon is separated. However, reports have stated that partial ruptures are not always considered a differential diagnosis and are often labelled as Achilles tendinopathy (Gatz *et al.*, 2020; Kayser *et al.*, 2005).

The majority of individuals with TA ruptures present with a history of a distinct ‘popping or snapping sound/sensation’ when the injury occurs, as well as sudden and severe pain in the area of the tendon. Patients often describe a sensation of “being kicked in the back of the calf” (Elias & McKinnon, 2011; Hess, 2010). There is also evidence of loss of plantar flexion in which the patient may complain of difficulty standing on their toes, running, or walking upstairs (Egger & Berkowitz, 2017). Therefore, those suffering from TA reports additionally report significant pain and disability (Gatz *et al.*, 2020).



Patients additionally also often have a positive Thompson test (Boyd *et al.*, 2015; Egger & Berkowitz, 2017). The Thompson test allows for the assessment of the continuity of the Achilles tendon. With the Thompson test, the patient is positioned in the prone position with the foot and ankle at rest. The examiner then proceeds to squeeze the calf of the injured extremity in order to observe the presence and degree of plantarflexion at the foot and ankle. This is then compared to the contralateral extremity. A positive (abnormal) Thompson test is one in which there is failure of plantarflexion upon squeezing the calf (Aminlari *et al.*, 2021; Boyd *et al.*, 2015). This is greatly indicative of an Achilles tendon rupture. The Thompson test is reported as 96% sensitive and 93% specific in diagnosing TA ruptures (Maffulli, 1998).

Therefore, Achilles tendon rupture is usually a clinical diagnosis based on history and clinical examination (Chan *et al.*, 2017). However, imaging is indicated in order to evaluate the extent of the injury as well as to exclude other suspected pathologies of the Achilles tendon (Dams *et al.*, 2017). Imaging modalities that can be used include plain radiographs, MRI, or ultrasound. Plain radiographs are often used to rule out fractures, while MRI and ultrasound can confirm the clinical suspicion of a TA rupture.

However, ultrasound is regarded as the best initial imaging modality for TA ruptures. It is a highly sensitive, reliable, and non-invasive diagnostic tool that has an important role in assessing Achilles tendon injuries (Åstrom *et al.*, 1996; Elias & McKinnon, 2011; Molyneux *et al.*, 2017). In partial ruptures, ultrasound findings usually include a thickened tendon of >1 cm in diameter, the presence of intact Achilles tendon fibers, and fluid surrounding the affected site of rupture. However, in complete ruptures, ultrasound will report a loss of the normal tendon architecture with a total loss of continuity in its fibers (Aminlari *et al.*, 2021).

In previous studies, ultrasound was reported to have 100% sensitivity, 83% specificity, and 92% accuracy in differentiating between incomplete and complete TA ruptures (Hartgerink *et al.*, 2001). In another study, ultrasound was reported to have 94.8% sensitivity and 98.7% specificity for detecting complete Achilles tendon ruptures in patients who underwent surgical management (Aminlari *et al.*, 2021). Therefore, according to these standards and results, ultrasound is regarded as a primary tool for diagnosing Achilles tendon injuries (Sakr *et al.*, 2019).

However, this study aims to investigate the reliability of ultrasound in differentiating between partial and complete TA ruptures. It also aims to establish whether ultrasound findings of TA ruptures are in accordance with intraoperative findings.

2. MATERIALS AND METHODS

2.1. Study Design

All cases of operatively treated Achilles tendon ruptures in an acute trauma hospital were identified and reviewed. Subjects who underwent nonstandard Achilles tendon repairs, such as grafted repairs or delayed treatment of chronic ruptures, were excluded. Those who were also treated conservatively and subjects who did not receive an ultrasound during their acute assessment were also excluded. Institutional review board approval was obtained. Their charts were obtained, and the operative notes, reports, and imaging of these patients were reviewed.

2.2. Image Acquisition and Analysis

Ultrasound data was collected retrospectively. A non-homogenised group of radiology consultants performed an ultrasound. Radiology consultants were essentially blinded to the true result, which was only found intraoperatively. Patients were placed prone with their ankles off the end of the bed, flexed to 90 degrees, and dynamic ultrasonography was performed.

2.3. Variables

The radiological profile of each patient who underwent Achilles tendon repair was reviewed. Ultrasound reports were reviewed to assess for “complete” and “incomplete” rupture. Reports were not standardised in reporting “percentage completeness.” There were different radiologists reporting on ultrasound.

Operative records of each patient were reviewed to assess for intraoperative findings. The intraoperative findings were assessed to see if the rupture was described as “complete” or “incomplete” and synonyms thereof, e.g., partial.

2.4. Data Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 29 Mac (v29.0.1.0).

TABLE I: SUMMARY OF RESULTS

Ultrasound findings		Intraoperative findings		
		Complete rupture	Partial rupture	Total
Ultrasound findings	Complete rupture	14	1	15
	Partial rupture	8	0	8
	Total	22	1	23

TABLE II: SENSITIVITY AND SPECIFICITY OF ULTRASOUND

Ultrasound			Intraoperative			
			Complete	Partial	Total	
Ultrasound	Count	1	0	0	1	
		% within intraoperative	100.0%	0.0%	4.2%	
	Complete	Count	0	14	1	15
		% within intraoperative	0.0%	63.6%	100.0%	62.5%
	Partial	Count	0	8	0	8
		% within intraoperative	0.0%	36.4%	0.0%	33.3%
	Total	Count	1	22	1	24
		% within intraoperative	100.0%	100.0%	100.0%	100.0%

3. RESULTS

A total of 49 patients (12 female and 37 male) patients were identified to have had a ruptured Achilles tendon. The mean age was 42.67 years (range 18–65 years).

Of the 49 patients identified who were diagnosed with a TA rupture, 23 patients did have an ultrasound to confirm the diagnosis of TA rupture, in which 8 of the 23 patients (34.78%) were categorized as having ‘partial’ or ‘incomplete’ ruptures and 15 patients (65.23%) were categorized as having ‘complete’ ruptures.

Of the 8 patients who were reported to have ‘partial’ ruptures on ultrasound, 8 were discovered to be ‘complete’ intraoperatively. Additionally, of the 23 that were reported as ‘complete’ on ultrasound, 22 were discovered to be ‘complete’ intraoperatively, and 1 was discovered to be ‘partial’ (Table I).

The results in Table II indicate a sensitivity of 63.65%, specificity of 0%, and accuracy of 60.87%.

4. DISCUSSION

4.1. Ultrasound Accuracy in Achilles Tendon Rupture

Ultrasound is a safe, non-ionising imaging modality. The imaging modality is useful in diagnostic and procedural guidance (Weile et al., 2018). It is operator-dependent, and, therefore, the operator can correlate the findings of the clinical examination and history with those of the patient (Moore & Copel, 2011). Lee and Yun (2017) showed that the sensitivity of ultrasound in diagnosing Achilles tendon rupture or major ankle ligament injury was 59%–100% in a point-of-care setting. The gold standard used in this study was magnetic resonance imaging, not intraoperative findings. The operators were emergency medicine physicians and family medicine practitioners. Griffin et al. showed the utility of what they called “Real Time Achilles Tendon Ultrasound” (Griffin et al., 2017). They performed a 15-second Thompson test in the prone position under ultrasound guidance. These tests were done in patients who were already diagnosed with Achilles tendon rupture and were about to undergo surgery. Interestingly, they also showed that sensitivity was 86.4% for a novice group compared to 91.7% for an expert group. They used intraoperative findings to confirm the results. They did not distinguish between complete and partial tendon ruptures. As mentioned, a meta-analysis performed by Aminlari et al. (2021) showed that ultrasound had a sensitivity of 94.84%, a specificity of 98.7%, a positive likelihood ratio of 73.98 and a negative likelihood ratio of 0.05 (Aminlari et al., 2021). This meta-analysis compared intraoperative findings to ultrasound findings. This meta-analysis also reports directly on partial tendon rupture, sensitivity of 93.7%, specificity of 97.4%, positive likelihood ratio of 35.6, and negative likelihood ratio of 0.07.

Therefore, although ultrasound does have its advantages in that it is a safe, non-invasive, and less expensive imaging modality, this study illustrates that ultrasound has limited benefit in differentiating

between partial and complete TA ruptures with only a sensitivity of 63.65%. This may be because partial TA ruptures have a variable appearance on imaging when compared to complete ruptures (Elias & McKinnon, 2011). This highlights the limitations of ultrasound as a diagnostic tool in that it is widely user-dependent (Kayser et al., 2005).

4.2. History Taking and Clinical Examination in Achilles Tendon Rupture

There are many diagnostic tests that can be employed when examining an Achilles tendon rupture. The Thompson test performed in a prone position with the knee extended or flexed is one of these tests. The Thompson test may be accompanied by the presence of a palpable gap. It has been shown to have a sensitivity of 73% to 96% and a specificity of 85% to 93% (Boyd et al., 2015; Garras et al., 2012; Reiman et al., 2014).

4.3. Partial Achilles Tendon Rupture

The Achilles tendon has anatomic contributions from the gastrocnemius medial head, gastrocnemius lateral head, and soleus. Gatz et al. (2020) describe partial Achilles tendon rupture as an underdiagnosed entity (Gatz et al., 2020). A partial tear is defined as a partial discontinuation of the Achilles tendon and usually has an acute onset (Chan et al., 2017). Patients lack the ability to maximally load but may maintain the ability to train. Partial tendon ruptures have been classified on their histological features by Smigielski (2008). Partial tendon ruptures may be acute or chronic, showing (A) acute injury with fresh collagen damage or (B) chronic injury with fatty metaplasia. Smigielski also described an anatomic classification of the Achilles tendon as I, II, or III based on the number of injured bundles. This classification would be further subdivided by denoting the injured bundles by using S (soleal), GM (medial gastrocnemius) or GL (lateral gastrocnemius). For example, a partial tear of the medial gastrocnemius portion of the tendon would be denoted as follows A-I-GM. An acute complete tear would be A-III-GL, GM, S.

5. CONCLUSION

While ultrasound is a good imaging modality for the detection of TA rupture, it may have some difficulty in determining the difference between partial and complete ruptures. There also evidently seems to be an overdiagnosis of partial ruptures on ultrasound reports, as the majority of ruptures identified as partial were discovered to be complete in theatre.

It is important to be able to differentiate between partial and complete TA ruptures, as this may have an effect on whether the injury is treated surgically or conservatively. Therefore, accuracy needs to be maintained when using ultrasound as an imaging modality for the differentiation between partial and complete TA ruptures.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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