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CLINICAL RESEARCH

MRI is Unnecessary for Diagnosing Acute Achilles Tendon Ruptures

Clinical Diagnostic Criteria

David N. Garras MD, Steven M. Raikin MD, Suneel B. Bhat MD, MPhil, Nicholas Taweel DPM, PT, Homyar Karanjia DPM

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Abstract

Background Achilles tendon ruptures are common in middle-aged athletes. Diagnosis is based on clinical examination or imaging. Although MRI is commonly used to document ruptures, there is no literature supporting its routine use and we wondered whether it was necessary.

Questions/purposes We (1) determined the sensitivity of physical examination in diagnosing acute Achilles ruptures, (2) compared the sensitivity of physical examination with that of MRI, and (3) assessed care delays and impact attributable to MRI.

Methods We retrospectively compared 66 patients with surgically confirmed acute Achilles ruptures and preoperative MRI with a control group of 66 patients without preoperative MRI. Clinical diagnostic criteria were an abnormal Thompson test, decreased resting tension, and palpable defect. Time to diagnosis and surgical procedures were compared with those of the control group.

Results All patients had all three clinical findings preoperatively and complete ruptures intraoperatively (sensitivity of 100%). MR images were read as complete tears in 60, partial in four, and inconclusive in two patients. It took a mean of 5.1 days to obtain MRI after the injury, 8.8 days for initial evaluation, and 12.4 days for surgical intervention. In the control group, initial evaluation occurred at 2.5 days and surgical intervention at 5.6 days after injury. Nineteen patients in the MRI group had additional procedures whereas none of the control group patients had additional procedures.

Conclusions Physical examination findings were more sensitive than MRI. MRI is time consuming, expensive, and can lead to treatment delays. Clinicians should rely on the history and physical examination for accurate diagnosis and reserve MRI for ambiguous presentations and subacute or chronic injuries for preoperative planning.

Level of Evidence Level II, diagnostic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

D. N. Garras (✉), S. B. Bhat
Department of Orthopaedic Surgery, Thomas Jefferson University Hospital, 1015 Walnut Street, Room 801, Philadelphia, PA 19107, USA
e-mail: dgarras@gmail.com

S. M. Raikin, N. Taweel, H. Karanjia
Foot and Ankle Division, Rothman Institute, 925 Chestnut Street, Philadelphia, PA 19107, USA

S. M. Raikin
e-mail: Steven.raikin@rothmaninstitute.com

Introduction

The Achilles tendon is the most frequently ruptured tendon [12, 13, 15, 19, 27]. The incidence of Achilles ruptures is estimated to be 18 per 100,000 and has been steadily increasing during the past few decades [4, 6, 10–12, 20]. Achilles ruptures currently account for approximately 40% of all operative tendon repairs [10]. Loss of Achilles function leads to loss of plantar flexion strength, weakness, fatigue, limp, and inability to run, heel rise, play sports, and climb stairs [8, 10, 12, 15, 19]. Delay in treatment, whether operative or nonoperative, reportedly has detrimental effects on the final outcomes [4, 5, 7, 18, 21, 22]. Therefore, it is important to accurately diagnose an acute injury and begin the treatment early.

Diagnosis of acute Achilles tendon ruptures most often is based on clinical criteria [4, 6, 8, 10, 12, 14, 17, 20]. Various physical examination techniques have been described to this end [4, 8, 12–15, 17, 19, 24, 25]. MRI and ultrasound have been widely used in confirming the initial diagnosis, without analysis of their need [2]. The American Academy of Orthopaedic Surgeons clinical practice guidelines recommendation was inconclusive regarding routine use of MRI and for diagnosing acute Achilles ruptures owing to the lack of evidence in the literature to support its use [2, 3, 9].

We therefore (1) determined the sensitivity of our physical examination diagnostic criteria, (2) determined the sensitivity of MRI and compared it with the sensitivity of the clinical examination, and (3) examined delays in treatment as a result of obtaining MRI and the implications of those delays.

Patients and Methods

This study was approved by the Institutional Review Board at our institution. We performed an institutional database search of consecutive patients with either an International Classification of Diseases, 9th Revision code 727.67 (Achilles tendon rupture) and/or a Current Procedural Terminology code of 27650 (primary repair Achilles tendon rupture) between 2001 and 2009. The search yielded 273 patients with an acute Achilles rupture confirmed by surgical evaluation. During the study time we treated a total of 64 patients with acute Achilles ruptures nonoperatively (26 complete and 38 partial). The indications for surgery were (1) acute injury, (2) young and active patients, and (3) clinically confirmed complete ruptures with or without MRI diagnosis. The contraindications were (1) medical comorbidities prohibiting surgery, (2) sedentary elderly patients, and (3) wounds and infections in the surgical area. For this study we excluded patients with suspected concomitant injury or disorders (such as known chronic Achilles tendinosis), subacute (more than 4 weeks from the injury) or chronic ruptures, open lacerations, myotendinous junction-level ruptures, prior surgery to the Achilles tendon, or rerupture of the Achilles tendon. Of the 273 patients, 66 with clinically diagnosed complete rupture of the Achilles tendon who presented with preoperative MR images constituted the experimental group. This included 55 males (83.3%) and 11 females (16.7%) with an average age of 45.2 years (95% CI, 42.5–47.9). All MR images were ordered by a primary care physician or the initial evaluator before being referred to our institution. Thirty patients injured their right side and 36 injured their left side. Eight patients (12.1%) reported prodromal symptoms of tendinosis before their injury, but none had ever received treatment for tendinosis. At the time of injury, 48 patients were participating in sporting activities (72.7%), 11 had work-related injuries (16.7%), and seven had an accidental injury such as a fall (10.6%). The experimental group was compared with a randomly selected control group of 66 age- and gender-matched patients who did not have MRI before their initial evaluation. The control group was comprised of 57 males (86.4%) and nine females (13.6%), with a mean age of 41.7 years (95% CI, 39.1–44.3). Thirty-four patients had a right-sided injury and 32 had a left-sided injury.

All patients were examined in the office by the senior author (SMR) before surgery and clinically diagnosed with an acute Achilles tendon rupture based on history and physical examination findings. Our clinical examination criteria for the diagnosis of an acute Achilles rupture is the presence of an abnormal Thompson test (no ankle plantar flexion with the examiner squeezing the patient's calf), decreased ankle resting tension compared with the contralateral uninjured side (normal resting tension is approximately 20° to 30° plantar flexion), and a palpable defect in the Achilles tendon.

Records were reviewed for the date of the injury, who ordered the MRI when one was performed, date of the MRI examination, date of initial evaluation by the treating surgeon, and date of the surgical procedure. The operative notes were reviewed for additional procedures that were performed. Indications for a flexor hallucis longus transfer were gapping after primary repair, insufficient quality of the tendon attributable to injury, atrophy, or tendinosis, and rupture gap greater than 3 cm requiring lengthening. Indication for V-Y lengthening was a 3- to 5-cm rupture gap.

During the initial evaluation, one of us (SMR) reviewed the MR images and recorded his interpretation in the chart. Additionally, the official radiologist report was included in the chart. These then were compared with intraoperative findings as recorded in the operative reports. Because these were ordered by and performed at outside institutions, we had no control of the MRI equipment, quality, sequences used, or who read the MRI.

Statistical analysis consisted of ANOVA and Fisher's post hoc tests in comparing demographics or times between the two groups using commercially available computer software, StatView (SAS Inc, Cary, NC, USA).

Results

The presence of all three clinical examination findings predicted a complete tear in 100% of the patients. In both groups, all 132 patients had an abnormal Thompson test, decreased resting tension of the ankle, and a palpable defect in the Achilles tendon during their initial evaluation by the treating surgeon. All patients were confirmed to have complete ruptures of their Achilles tendon intraoperatively.

MRI sensitivity in this cohort based on the radiologists' interpretations was 90.9%. Of the 66 patients with preoperative MRI, a diagnosis of a complete tear was made in 60 patients (90.9%) based on the radiologists' readings. In four patients (6.1%), the MR images were read as showing a partial tear. There were two MRI studies that were read as "unable to exclude a complete tear" (3.0%). All MRI studies were interpreted by the senior author (SMR) as showing complete ruptures, with the added benefit of having personally examined the patients.

Referral for treatment was delayed in the MRI group when compared with the control group. In the MRI group, it took on average 5.1 days (95% CI, 4.0–6.3) to obtain MRI after the initial injury. The patients' initial referral to, and evaluation by, the surgeon occurred at a mean of 8.8 days (95% CI, 7.2–10.5) and surgical intervention at a mean of 12.4 days (95% CI, 10.5–14.3) after the initial injury. In a matched control group of patients who did not have MRI, the initial evaluation by the surgeon occurred at a mean of 2.5 days (95% CI, 2.2–2.8), and surgical intervention occurred at 5.6 days (95% CI, 5.0–6.2) after the injury (Table 1). The differences between the time to initial evaluation and diagnosis by the treating surgeon and the time to surgical intervention were greater ($p < 0.001$) for the MRI group than the control group.

None of the clinically diagnosed control patients who did not have MRI preoperatively required any additional procedures. Nineteen patients in the MRI group required additional procedures at the time of the index repair. These included flexor hallucis longus tendon transfer in 17 patients and V-Y myotendinous advancement to approximate the tendon ends in six patients (five patients required both procedures). For patients requiring additional procedures, the mean time to obtain MRI was 7.0 days (range, 0–22 days), mean time to initial evaluation was 10.6 days (range, 1–30 days), and the mean time to surgical intervention was 14.7 days (range, 4–30 days) (Table 2). When compared with the rest of the MRI group, patients requiring additional procedures had longer times to diagnosis and treatment ($p = 0.008$ and < 0.001, respectively), but no demographic differences (Table 2).

Discussion

The diagnosis of acute Achilles ruptures is based on clinical findings; imaging generally is not indicated except in cases of equivocal examination findings [4, 6, 8, 10, 12, 14, 17, 20]. In this study, we retrospectively reviewed patient records to determine the sensitivity of our physical examination criteria, compare it with reported MRI sensitivity and our own, and determine if obtaining MRI led to delays in diagnosis and treatment and their implications.

We recognize some limitations to our study. First, the study was retrospective and therefore susceptible to selection bias. However, since this was a consecutive series of patients with none excluded, we do not believe that selection bias affected these results. Second, the radiologists' and the senior surgeon's (SMR) impressions of the images were reviewed. However, the MR images were not available in this retrospective review. Third, as the MRI studies were performed at multiple centers, there exists variability in the quality of the imaging and equipment used. Additionally, the MRI studies were read by multiple radiologists with differing levels of training and experience which provides for unaccountable interobserver variability. The senior author (SMR) personally reviewed all MRI

Table 1. Comparison of patients with and without preoperative MRI

Variables	Patients with MRI (95% CI)	Patients without MRI (95% CI)	p value
Number of patients	66	66	
Male:female	55:11	57:9	
Right:left	30:36	34:32	
Mean age (years)	45.2 (42.5–47.9)	41.7 (39.1–44.3)	0.11
Mean followup (years)	3.5 (3.0–4.0)	3.6 (3.3–3.8)	0.89
Time from injury to MRI (days)	5.1 (4.0–6.3)	N/A	N/A
Time from injury to initial evaluation (days)	8.9 (7.2–10.5)	2.5 (2.2–2.8)	< 0.001
Time from injury to surgical intervention (days)	12.4 (10.5–14.3)	5.6 (5.0–6.2)	< 0.001
Additional procedures	19 patients (28.8%): 17 FHL transfers, and 6 V-Y advancement	0 patients (0%)	

FHL = flexor hallucis longus; N/A = not applicable.

Table 2. Comparison of patients with preoperative MRI requiring additional procedures

Variables	Patients with additional procedures (95% CI)	Patients without additional procedures (95% CI)	p value
Number of patients	19 (28.8%)	47 (71.2%)	
Male:female	15:4	40:7	
Right:left	8:11	22:25	
Mean age (years)	49.5 (43.7–55.3)	44.9 (40.0–48.9)	0.18
Mean followup (years)	4.6 (3.7–5.5)	4.6 (3.9–5.1)	0.98
Time from injury to MRI (days)	7.0 (4.0–10.0)	3.7 (2.9-4.5)	0.005
Time from injury to initial evaluation (days)	10.6 (7.2–14.1)	6.8 (5.6–8.0)	0.008
Time from injury to surgical intervention (days)	14.7 (11.4–18.1)	9.6 (8.4–10.9)	< 0.001
Additional procedures	17 FHL transfers, 6 V-Y advancement	N/A	

FHL = flexor hallucis longus; N/A = not applicable.

studies at the time of the initial evaluation, with the additional benefit of personally examining the patients and he used this information in his interpretation. Most of the patients were referred to us because of an abnormality seen on their MR images and therefore, we cannot say there is no benefit to obtaining MRI. However, as the main object of this study was to determine the accuracy of the physical examination rather than MRI, we do not believe these variations would jeopardize our results.

Many physical examination maneuvers and findings have been described. The Thompson test is performed with the patient prone and the knee flexed to 90°. The calf is squeezed, which lifts the gastrocnemius and shortens the Achilles, leading to plantar flexion of the foot if the Achilles is intact [4, 8, 12–15, 17, 19, 24, 25]. Diminished or absent plantar flexion is indicative of a rupture. The Thompson test had the highest sensitivity and specificity, 0.96 and 0.93, respectively [9, 13]. The Matles test, used in our study in the form of resting tension, is performed with the patient prone and the knee at 90°, which should shorten the gastrocnemius leading to plantar flexion of the ankle to 20° to 30° if the Achilles is intact [8, 12–17, 19]. It has a sensitivity of 0.88 and a specificity of 0.85 [13, 16]. The presence of a palpable gap in the tendon has a sensitivity of 0.73 and a specificity of 0.89 [9, 13]. Maffulli et al. concluded that if two or more of the previously mentioned tests were positive, then the diagnosis was "certain" [13–15]. The American Academy of Orthopaedic Surgeons clinical practice guidelines requires the presence of two or more of the following for the diagnosis: an abnormal Thompson test, decreased plantar flexion strength, a palpable gap, or increased passive dorsiflexion [2, 3]. In this study, we used the Thompson test, resting tension, and a palpable gap as our diagnostic criteria for acute Achilles tendon ruptures, all of which are noninvasive, were well tolerated by patients even in the acute setting, and are highly reliable. Individually, each examination has a high sensitivity and specificity, but in our study, the combination of all three clinical diagnostic criteria improves the sensitivity to 100%.

Furthermore, the clinical diagnostic criteria used in our study were more sensitive than MRI studies. MRI is the most useful modality for soft tissue injuries but is expensive and may not be accessible in certain areas [26]. MRI allows for evaluation of the extent of the rupture and the condition of the tendon ends [8, 15]. Tendon discontinuity, fraying, and retraction are best evaluated on sagittal T2-weighted MR images [8, 15]. MRI has a sensitivity of 0.95 and a specificity of 0.50 [23]. In our study, 90.9% of the MRI studies were accurate with the remaining 9.1% being inaccurate or inconclusive but indicating some problem with the Achilles.

Delays in treatment result from decreased pain after the initial injury and misdiagnosis by the first evaluator in as much as 20% to 36% of patients [1, 4, 8, 10, 12, 14, 15, 17, 19]. These delays reportedly compromise the end clinical result [4, 5, 7, 18, 21, 22]. If an acute rupture is missed and becomes chronic, there is 20% less endurance of the muscle and the treatment becomes more difficult [19]. Although the delay caused by obtaining MRI is likely the result of the precertification process or availability of the testing center and is not an inherent problem with the MRI, our patient population experienced a delay in initial evaluation by the treating surgeon. There were no other discernable differences between the MRI and control groups that would have led to the delays seen for the MRI group. Additionally, the only difference observed in the MRI group between patients who required additional procedures and the remainder of the group was the delay to diagnosis and treatment (Table 2). Although the modest delay we observed is not likely to lead to deterioration of

Table 3. Indications for obtaining MRI for acute Achilles injuries

Inconsistent examination; presence of one or more of the following
Normal or equivocal Thompson test
Normal resting tension compared with uninjured side
Nonpalpable gap between tendon edges
Injury occurring greater than 4 weeks
Known chronic rupture
Rerupture, prior tear, or trauma
Prior Achilles surgery
History of chronic tendinosis
Atraumatic mechanism of injury

patient outcomes alone, it is an unnecessary delay which might contribute to lower outcomes.

We also recognize situations when advanced imaging is indicated and extremely useful for Achilles tendon injuries (Table 3). Our study examined only acute Achilles tendon injuries and it has no bearing on chronic injuries or tendinosis. Even in the acute setting, patients who have an Achilles injury but have inconsistent findings on clinical examination require MRI. In addition, patients with subacute or chronic tears, with the injury occurring more than 4 weeks before evaluation, may have alterations in their examination findings owing to the presence of interposed scar tissue. Many of these patients may not have an abnormal Thompson's test as a result of scar bridging, potentially confusing the clinical findings. Additionally, preoperative assessment of the extent of the rupture gap may be useful in planning any proposed surgical correction. Finally, in patients with a history of prior tendinosis, atraumatic mechanisms, and if there was a prior tear or trauma for which revision surgery is planned, an advanced imaging study should be obtained to determine the extent of damage, assess the gap [19], and plan for additional procedures [14, 23]. Because advancements in medical imaging technologies continue to be accompanied by costs of implementation that preclude their practical daily use, it is most important to rely on sensitive and specific physical examination tests that negate the need for advanced imaging in the majority of acute Achilles tendon ruptures. In the current study, physical examination findings, including an abnormal Thompson test, a palpable defect, and decreased resting tension, were more sensitive in diagnosing a complete Achilles rupture than MRI, leading to earlier diagnosis and treatment. MRI is time consuming, expensive, and can lead to a delay in treatment and misdiagnosis [26]. Clinicians should rely primarily on the history and physical examination and have heightened awareness of a potential Achilles rupture based on the mechanism of injury for accurate diagnosis and management and reserve MRI for ambiguous presentations and subacute or chronic injuries for preoperative planning. Not all patients will have all three physical examination findings; therefore, we recommend careful evaluation and judicious use of advanced imaging as needed.

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