Where In The Watershed Does The Achilles Rupture? A More Detailed Analysis of Achilles Tendon Ruptures With Surgical Recommendations.

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Introduction

The Achilles tendon is the strongest but most ruptured tendon in the body. Most often this is due to trauma to the tendon with a rupture in the "Watershed" (WS) area range of 2-7 cm proximal to the insertion point on the calcaneus. When surgical repair is performed, Kuwada defined grades of rupture distances between ends with recommendations based on the grade. However, a factor just as important as distance between ruptured ends is the distance of the rupture from the Achilles insertion. Many repair techniques require a certain amount of healthy tendon on either side of the rupture for appropriate suture or graft purchase to prevent pull-out and re-rupture. Here we perform a retrospective review of Achilles tendon ruptures in an attempt to define a most common distance from the insertion where ruptures occur, whether it is in the proximal or distal WS area. Just as important as knowing the rupture gap distance (Kuwada), is knowing the distance of the rupture from the insertion for surgical planning. Because of this, recommendations are made based on the literature as to the type of repair most appropriate for each of these regions ruptures.

Methods

A retrospective EMR chart review was performed from the patient population of the senior author from 3/1/2010 – 9/30/2015 with identification through an ICD-9 code search of 727.67 (Rupture of tendon, non-traumatic; Achilles tendon) and 845.09 (Sprain and strain of ankle and foot; Achilles tendon). A chart review was performed with the primary data point of distance from insertion to rupture in millimeters (mm) using MRI. The inclusion criteria included patients with a full and partial AT rupture diagnosed on an accessible MRI that has a calibrated measurement tool.

The MRI review was performed by a post-graduate foot and ankle fellow. The PACS system sagittal plane MRI (T2 or T1) sequence was used with a calibrated ruler to measure from the defined insertion, proximally to the rupture site. Distances were categorized into three zones (Zone 1 = insertion to 20mm; Zone 2 = "Watershed Zone" 20-mm to 60-mm; Zone 3 = > 60-mm) amended from work by Myerson and literature referencing the WS Zone.[1]

Of note, a literature review was performed to define the true insertion of the AT. Many textbooks generally state that it inserts on the posterior aspect of the calcaneus. Based on the work by Kim et al, the junction of the middle and superior third of the posterior calcaneus was defined as our AT insertion point and origin from which measurements were made.[2]

Results

The initial study population consisted of 156 patients with 157 limbs. After inclusion and exclusion criteria were applied, the rupture population was defined as 34 patients and 35 limbs. Ruptures were found in 3 zones: Zone 1 = 6, Zone 2 = 25, Zone 3 = 4. Within the WS, dividing the region in half, ruptures were split between proximal and distal WS Zone. Rupture gap averaged 34.8mm with Kuwada type 3 ruptures the most common at 57%.

Age	(n = 34)	
Average	45.9	
Male	46.2	(20 - 78)
Female	44.6	(33 - 54)
Sex	(n = 34)	
Male	29	83%
Female	5	17%
Laterality	(n = 35)	
Left	17	48.50%
Right	18	51.50%
Mechanism	(n = 35)	
Trauma	28	80%
Tendinosis	6	17%
Steroid	1	3%

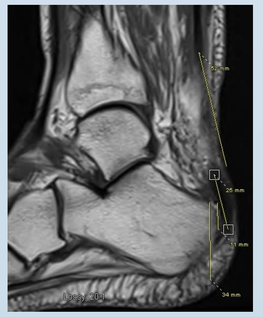
Rupture Zone	(n = 35)	
Zone 1 (0-20mm)	6	17%
Zone 2 (20-60mm)*	16	46%
Zone 3 (>60mm)	13	37%
Kuwada Classif.	(n = 35)	
Type 1	4	11%
Type 2	9	26%
Type 3	20	57%
Type 4	2	6%
Watershed Zone*	(n = 16)	
Region 1 (20-40mm)	8	50%
Region 2 (40-60mm)	8	50%

Zone / Gap+	Preparation	Repair
Zone 1 (0 – 20-mm proximal to insertion)	- Debridement of insertion (if in face of Haglunds); - Creation of distal tissue cuff for graft overlap	-Distal bone/suture anchor into calc. w proximal extension end-end repair. -Distal trans-calc. graft (plantaris, FHL; allo) with use of bone anchor. - Aponeurotic flap down with suture/bone anchor into posterior calc.
Zone 2 (20 – 40-mm proximal)	- Debridement of proximal and distal stumps	- End-to-end; aponeurotic flap-down - Graft (autograft; allograft; synthetic) reinforcement - Consider Kuwada recs.
Zone 3 (> 60-mm proximal)	- Debridement of proximal and distal stumps	- Rupture Distance < 2-cm = End-to-end; flap down. - No Repair if at myotendon junction (Ahmad et al)[9]

Table 1. Recommendations – Achilles Insertion to Rupture Distance
NOTE: Surgeon should consider (1) distance to insertion and (2) rupture gap for appropriate repair technique. Clinical judgment is expected in all instances.

Discussion

- The results here demonstrate close to 50% of the ruptures occurred in the WS with a 50/50 split between proximal and distal WS. Although no comparison literature was found to draw WS conclusion, our results did follow in defining the WS as the most common location for a rupture.
- The classification that Kuwada gives us is helpful in determining what repair technique to use in reconstruction of the AT to restore strength and function based off of rupture gap distance.[3] (Table 1) However, from our experience, the location of the rupture often also adds another component to determining the type of repair that best fits. When the tendon is torn closer to the insertion, regardless of the rupture gap (Kuwada Type) or location in the WS region, an end-to-end repair may not be the most optimal choice. This is in part due to the lack of healthy tendon distance to run a stitch or place a "patch" graft to reinforce an end to end repair.
- Wu et al (2015) in a cadaver study studied simulated ruptures 5 and 10mm from the insertion repaired with PB tendon grafts overlapping the residual distal cuff of tendon. Their results demonstrated significantly greater mean load to failure in the 10mm overlap group compared to the lesser 5mm of cuff available showing the need for greater distal AT for a strong repair.[4] Non-avulsion, distal insertional ruptures may require a suture anchor or trans-calcaneal construct regardless of the Kuwada directed repair (based off of the size of the gap) due to the available distal tendon.[5] Myerson has demonstrated that in Zone 1 ruptures, end-to-end repairs are not possible even if the gap is less than 2 cm.[1] Further, Kumar et al (2013) states that Zone 2 ruptures, especially chronic in nature, do not have a distal stump suitable for direct, end-to-end, repair.[1] These points are why a new classification system is needed based on location/zone of rupture and not just gap distance (Kuwada) to help aid in appropriate repair techniques.
- Distal ruptures with minimal healthy tendon on the insertion end appear to be the most affected by this notion. They may require the use of techniques such as an aponeurotic flapdown, Lindhold, or flexor hallucis longus tendon transfer with anchoring into the calcaneus in order to gain healthy tendon on the insertional end of a rupture.[6–8] The lead author often uses a tendon graft or synthetic graft incorporated to the insertion or anterior side of the short distal stump with a bone/suture anchor into the calcaneus to provide a solid starting point for repair to prevent pull-out or elongation (below). Alternatively, Zone 3 ruptures near or at the myotendinous junction have shown similar rates of healing and functional outcomes with non-surgical methods and a lack of repair may be indicated.[9]



Citations available upon request.