**Acute Achilles Tendon Ruptures**

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**Educational Objectives**

As a result of reading this article, physicians should be able to:

1. List the etiology and associated conditions related to an Acute Achilles tendon rupture.
2. Describe the typical presentation of a patient with an acute Achilles tendon rupture and discuss how to clinically recognize and diagnose these injuries.
3. Identify surgical and nonsurgical treatment options and the risks and benefits between nonsurgical and surgical treatment.
4. Discuss the importance of an early functional mobilization program following Achilles tendon repair and its resulting change in patient outcomes.

Acutely ruptured Achilles tendons most commonly affect individuals in their third to fifth decade of life who are intermittently active. Previously, a bimodal age distribution was reported but a 2006 study by Suchak et al reported a mean incidence of 8.3 ruptures per 100,000 people with a peak incidence in the 30- to 49-year-old age group. There is agreement in the literature that intratendinous degeneration plays a role in the underlying pathology of acute Achilles tendon ruptures. All patients in the series reported by Cetti et al in 2003, showed degenerative changes at the site of rupture on histological examination of a biopsy taken at the time of surgical repair.

**Etiology**

The etiology of Acute Achilles tendon ruptures is multifactorial and includes

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**Instructions**

1. Review the stated learning objectives at the beginning of the CME article and determine if these objectives match your individual learning needs.
2. Read the article carefully. Do not neglect the tables and other illustrative materials, as they have been selected to enhance your knowledge and understanding.
3. The following quiz questions have been designed to provide a useful link between the CME article in the issue and your everyday practice. Read each question, choose the correct answer, and record your answer on the CME REGISTRATION FORM at the end of the quiz.
4. Type or print your full name and address and your date of birth in the space provided on the CME Registration Form.
5. Indicate the total time spent on the activity (reading article and completing quiz). Forms and quizzes cannot be processed if this section is incomplete. All participants are required by the accreditation agency to attest to the time spent completing the activity.
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overuse injuries, host factors, medications, or inappropriate footwear. Acute ruptures of the Achilles tendon are predominately overuse injuries in the recreational athlete. In runners with acute and overuse injuries, Achilles tendinopathy was the most common running-associated tendinopathy, and those running for >10 years had an increased risk for Achilles tendinopathy.4 Athletes with a recent change in their training schedule are also at increased risk of tendon injury. Similarly, military recruits beginning basic training, decreased plantar flexion strength and increased dorsiflexion excursion were significant predictors of an overuse injury of the Achilles tendon.5

Langbern et al6 found no alteration in the blood flow to the region of the tendon with the highest incidence of injury. In contrast, Chen et al.7 found the midsection of the tendon to be hypovascular, especially in patients with compromised blood supply. Patients with either a biomechanical malalignment, hyperpronation and cavus foot, or marked forefoot varus are at an increased risk of developing Achilles tendon complaints.3 Other predisposing factors include fluoroquinolone, hormone replacement therapy or steroid use, Ochronosis, prior Achilles tendon rupture, infection, hypertension, obesity or systemic inflammatory condition. Holmes and Lin8 observed that obesity, hypertension, hormone replacement therapy, birth control pills and steroids were all associated with Achilles tendinopathy. Kvist3 reported that shoe dependent factors were involved in 10% of Achilles tendon injuries in his study.

ANATOMY
The Achilles tendon is a conjoined tendon composed of the gastrocnemius and soleus muscles with occasional contribution from the plantaris muscle, and it inserts on the calcaneal tuberosity. The plantaris muscle is absent in 6% to 8% of individuals. The Achilles tendon is approximately 15-cm long and is the largest and strongest tendon in the human body. The tendon spirals approximately 90° from its origin to its insertion and this twisting produces an area of stress approximately 2- to 5-cm proximal to its insertion. The tendon has no true synovial sheath; instead it is wrapped in a paratenon. The Achilles tendon experiences the highest loads of any tendon in the body, and bears tensile loads up to 10 times body weight during athletic activities.9 The tendon most commonly ruptures in a region 2- to 6-cm proximal to its insertion.

The Achilles tendon receives its blood supply from the posterior tibial and peroneal arteries, and its blood supply is divided into 3 regions: the musculotendinous junction, the mesotenon, and the tendon-bone junction. The posterior tibial artery supplies blood to the proximal and distal parts of the tendon with the middle part supplied by the peroneal artery. In an anatomic study the midsection of the tendon tends to be hypovascular, which may explain the higher incidence of midsection tendon ruptures, especially in patients with compromised blood supply.7

BIOMECHANICS
The Achilles tendon is a part of a complex myotendinous unit that spans across 3 joints, but when the muscles of the Achilles tendon contract it flexes the knee, plantarflexes the ankle, and supinates the subtalar joint. The gastrocnemius and plantaris originate proximal to the knee joint whereas the soleus originates on the proximal tibia. The gastrocnemius is composed of primarily fast twitch fibers and it plantarflexes the ankle joint and flexes the knee joint. The soleus is composed predominately of slow twitch fibers and functions as a postural muscle when then the center of gravity of the body passes anterior to the knee joint. The soleus also functions as the prime plantar flexor.8 During normal ambulation the subtalar joint becomes pronated and this subsequently imparts an internal rotation force to the tibia, but knee extension imparts an external rotation force to the tibia. Both combined movements translate into significant stress on the Achilles tendon.

BIOCHEMISTRY AND HISTOLOGY
The Achilles tendon is composed of fibroblasts surrounded by an extracellular matrix of collagen, mucopolysaccarides, elastin, and glycoproteins. The collagen is primarily type I and is organized in parallel bundles of fibrils. The fibroblasts are embedded in the bundles of fibrils. Each fibril is surrounded by an endotenon, and these units are surrounded by a highly vascular epitenon. With normal aging the structure of the Achilles tendon changes. These changes include decreased cell density, decreased collagen fibril diameter and density, and loss of fiber waviness, which may explain the higher incidence of tendon injury in older athletes.10

In patients with Achilles tendon pathology certain biochemical changes take place within the tendon, which may predispose the tendon to rupture. Biopsies of tendons in patients undergoing surgery for Achilles tendinopathy, found that in the region of the diseased tendon, the water content was highest, and the collagen content was subnormal with increased amounts of denatured and damaged collagen. They also found low pentosidine levels in the pathologic tissue, which indicates the presence young collagenous matrix. The authors concluded that based on their findings the collagen turnover rate is increased, therefore the natural biochemical composition of the collagenous matrix is compromised.11

CLINICAL PRESENTATION
Patients present with acute posterior ankle/heel pain and may give a history of “felt like someone kicked me from behind”. Patients may report a direct injury, or report the pain started with jumping or landing on a dorsiflexed foot. It is important to elicit in the history any recent steroid or fluoroquinolone usage including local steroid injections, and also any his-
tory of endocrine disorders or systemic inflammatory conditions.

On physical examination the area will appear swollen and ecchymotic, which may inhibit the examiners ability to detect a palpable defect. The patient will be unable to perform a single heel raise. To detect the presence of a complete rupture the Thompson test can be performed. The test is done by placing the patient prone on the examination table with the knee flexed to $90^\circ$, which allows gravity and the resting tension of the triceps surae to increase the dorsiflexion at the ankle. The calf muscle is squeezed by the examiner and a lack of plantar flexion is noted in positive cases (Figure 1). It is important to note that active plantar flexion may still be present in the face of a complete rupture due to the secondary flexor muscles of the foot. It has been reported that up to 25% of patients may initially be missed in the emergency department due to presence of active plantar flexion and swelling over the Achilles tendon, which makes palpation of a defect difficult.

IMAGING

Multiple imaging modalities have been used to diagnose Achilles tendon injuries, which include plain radiography, magnetic resonance imaging (MRI), and ultrasound. Each test has its own advantages and disadvantages.

Ultrasound is approximately used 4 times more often than MRI for diagnosing Achilles tendon ruptures in the United Kingdom. The advantages of ultrasound are that it is inexpensive, readily available in most hospitals, fast, repeatable, and allows for dynamic assessment of the tendon. Ultrasound is effective at evaluating the thickness of the tendon and the gap between the ends of the tendon in a complete rupture. The disadvantages are that is operator dependent and is not as effective as MRI in diagnosing partial tears.

The most widely used modality in the United States to diagnose acute ruptures of the Achilles tendon is MRI, which has the advantage of accurate detail of the soft tissue but the disadvantages of not being readily available, high cost, does not provide dynamic assessment of the injury, and does not enable the practitioner to readily evaluate tendon healing (Figure 2). Magnetic resonance imaging is also superior to other imaging modalities in diagnosing partial ruptures of the Achilles tendon Kayser et al, reported that the sensitivity was 0.5 and the specificity was .81 for detecting proximal partial ruptures of the Achilles tendon ultrasound. The authors concluded ultrasound is a useful tool, but that it is not sufficiently reliable enough to diagnose all Achilles tendon pathologies including partial ruptures. They recommend obtaining an MRI for the definitive diagnosis. In our practice we use MRI for equivocal cases, or when we suspect a partial rupture.

CLASSIFICATION

Kuwada in 1990 published a classification system to guide surgical treatment for Achilles tendon injuries. Type 1 is a partial tear, which he recommended treating in a cast. Type 2 is a complete rupture with a defect up to 3 cm, which he recommends treating with an end-to-end anastomosis. Type 3 injuries have a 3- to 6-cm defect after debridement of the tendon ends to healthy tissue. He recommends treating this injury with a tendon graft flap, with possibly a synthetic graft augmentation. A V-Y advancement, a Bosworth turndown, tendon transfer, or a combination of these may also be used for type 3 injuries. Lastly, a Type 4 injury is a defect >6 cm and requires a gastrocnemius recession, a turndown, tendon transfer, free tendon graft, and/or synthetic graft, or a combination of these (Table).14

TREATMENT

Recent studies have shown successful outcomes with nonoperative and operative treatment. Comparative studies between nonoperative and operative treatment show a higher rate of re-rupture with nonoperative treatment, but also show risks of wound healing, wound infection, and nerve injury with operative treatment. Studies have published a re-rupture rate of 4.3% to 23% in nonoperatively treated patients compared to 1.7% to 10% for operatively treated patients. In a meta-analysis published by Khan et al in 2005.
of randomized controlled trials of acute Achilles tendon ruptures the authors concluded that open operative treatment results in a significant reduction in the risk of re-rupture when compared to nonoperative treatment. Operative treatment was associated with a significantly higher risk of wound complications, adhesions, infection, and nerve injury. They also concluded that the risk associated with surgical treatment may be reduced by percutaneous surgery and postoperatively splinting the limb with a functional brace; however, percutaneous treatment may be associated with a higher risk of sural nerve injury. Recent studies have also shown improved functional outcomes with early motion and weight bearing.\(^\text{21-25}\)

**Nonsurgical Treatment**

The most widely used method of nonsurgical treatment involves the use of serial casting with gradual progression from plantar flexion to neutral or using a solid removable boot with heel inserts to bring the ends of the tendon closer together. The advantage of a solid removable boot is that it allows the patient to begin early motion and is removable. Wide variability exists among surgeons in regards to the period of absolute immobilization, initiating range of motion exercises, and progression of weight bearing status.

Hufner et al\(^\text{15}\) reported 73.5% good to excellent results and 17.5% poor results with functional nonoperative treatment when ultrasound the tendon ends were <10 cm apart with the ankle in neutral and complete apposition of the tendon ends with the foot in 20\(^\circ\) of plantar flexion. Based on their findings they changed their protocol to include a repeat ultrasound examination by an experienced sonographer 2 to 5 days after the first to confirm the indications. They also extended the time a patient is kept in a high-shaft boot with a 3-cm hindfoot elevation from 6 to 8 weeks. Lastly, their patients would wear a 1-cm hindfoot elevation for another 3 months.\(^\text{15}\)

A prospective, randomized, multicenter study of 112 patients with 2-year follow-up comparing surgical treatment followed by early functional rehabilitation versus nonsurgical treatment with a plaster splint for 8 weeks. Identical rehabilitation protocols were used for both groups. The authors found that the rate of re-rupture was 20.8% in the nonoperative group compared to 1.7% in the surgical group.\(^\text{16}\)

Costa et al,\(^\text{17}\) in a randomized controlled trial, compared immediate functional weight bearing versus cast immobilization in nonsurgically treated patients, and the authors found no functional benefit from immediate weight bearing. The authors showed that immediate weight bearing did not predispose the patients to a higher complication rate, and they found no evidence of tendon elongation or a higher rate of re-rupture with immediate weight bearing compared to casting and nonweight bearing.\(^\text{17}\)

In a prospective randomized study by Twaddle and Poon\(^\text{18}\) the authors compared open surgical treatment versus nonoperative treatment. Twenty patients were in the operative group and 22 patients in the nonoperative group with a total of 1-year follow-up. The patients were all treated with an equinus cast for 10 days and then received an orthosis. Protected weight bearing was initiated at 6 weeks and crutches were discontinued at 8 weeks. Range of motion exercises were initiated with an orthosis. The authors found no difference in motion, calf circumference, musculoskeletal functional assessment, instrument scores, re-rupture rates, or complications. The authors concluded that controlled early motion is an important part of the treatment of Achilles tendon ruptures.\(^\text{18}\)

**Surgical Treatment**

The essence of surgical treatment involves 2 decisions; surgical technique and the postoperative regime.

Most published reports on surgical treatment fall into 3 different surgical approach categories that include the following: direct open, minimally invasive, and percutaneous. In multiple studies surgical treatment has demonstrated a lower rate of re-rupture compared to nonoperative treatment, but surgical treatment is associated with a higher rate of wound healing problems, infection, postoperative pain, adhesions, and nerve damage. Most commonly the direct open approach involves a 10- to 18-cm posteromedial incision. The minimally invasive approach has a 3- to 10-cm incision, and the percutaneous approach involves repairing the tendon through multiple small incisions. As with nonsurgical treatment there exists wide variation in the reported literature regarding postoperative treatment protocols. Multiple comparative studies have been published comparing different surgical approaches, repair methods, or postoperative treatment protocols.

### Table

**Classification of Achilles Tendon Injuries/Ruptures\(^\text{14}\)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Injury</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Partial tear</td>
<td>Nonoperative treatment</td>
</tr>
<tr>
<td>2</td>
<td>Complete rupture up to 3 cm defect</td>
<td>End-to-end anastomosis</td>
</tr>
<tr>
<td>3</td>
<td>3-6 cm defect</td>
<td>Tendon graft flap, possible synthetic graft, V-Y advancement, Bosworth turndown, tendon transfer, or combination</td>
</tr>
<tr>
<td>4</td>
<td>&gt;6 cm defect</td>
<td>Gastrocnemius recession, turndown, tendon transfer, free tendon graft, synthetic graft or combination</td>
</tr>
</tbody>
</table>

\[\text{Table}\]
Cretnik et al26 compared 132 percutaneous versus 105 open repairs of Achilles tendon ruptures and found a lower rate of major complications, equal AOFAS and Holz score, but a higher risk of re-rupture and sural nerve dysfunction with the percutaneous repair. Ceccearelli et al27 reported no re-ruptures and similar results for isokinetic strength, AOFAS scores, and time for return to work for either of the 2 groups. Lansdall et al28 examined the results of 163 Achilles tendon ruptures treated with a minimally invasive technique with functional after treatment. The authors reported 92% patient satisfaction, 5.5% major complications and a 9.2% incidence of sural nerve dysfunction. The major complications included re-rupture, deep infection, tendon necrosis and deep vein thrombosis (DVT).29 Most recently, Maffulli et al29 retrospectively examined results of 35 patients 65 years or older with the mean age of 73.4 years who underwent percutaneous repair for an acute rupture. Twenty-seven of 35 patients completed the appropriate follow-up of 49 months. The authors state that percutaneous repair of acute Achilles tendon ruptures in elderly patients produces similar outcomes to younger patients.29

In a meta-analysis, Khan et al20 found 14 studies with a total of 891 patients. The authors found that surgical treatment compared to nonoperative treatment resulted in a lower rate of re-rupture with a relative risk of 0.27, but surgical treatment had a higher risk of other complications with a relative risk of 10.60. The authors also compared percutaneous repair versus a direct open repair and found the percutaneous repair resulted in a shorter surgical time and a lower risk of infection with a relative risk of 10.52. Lastly, the authors compared postoperative functional bracing versus casting, and they showed that the functional bracing group had decreased inpatient stays and time off from work, returned to sports faster, and had a lower complication rate.3

Halasi et al30 examined percutaneous repair with or without tendoscopic control, and their results showed a lower re-rupture rate with tendoscopy but both techniques had similar results for return to sports, plantar flexion strength, and subjective scores. Jung et al31 retrospectively reviewed their results of 30 consecutive patients who underwent a limited open technique and the authors reported 2 re-ruptures, 1 deep infection, and 1 sural nerve injury. They concluded that the limited open technique provided an excellent cosmetic result, satisfactory functional results, and a high level of patient satisfaction.31

Atkas and Kocaoglu32 compared open repair versus a minimally invasive repair with the Achillon device (Integra LifeSciences Corp, Plainsboro, New Jersey). They showed similar functional scores between the 2 groups, improved surgical outcomes in regards to local tenderness, skin adhesions, and scar and tendon thickness in the Achillon group.32 Another study compared the strength of the Achillon tendon repair with a 2 strand Kessler repair technique with number 2 Ticon suture (Covidien, Dublin, Ireland) in a simulated sheep model. Their results demonstrated no difference between groups, suggesting the use of this specialty device is a biomechanically sound method of repair.33

Aktas et al34 treated 30 patients with acute Achilles tendon ruptures who underwent either an end-to-end repair or an end-to-end repair with plantaris augmentation with Krackow type sutures with epimembranous cross stitches. They reported no significant difference at 17 months postoperatively. A recent biomechanical study examined the difference in strength and gap resistance between a 4 strand Krakow and an epimembranous augmented 4 strand Krakow. The authors concluded that the epimembranous cross-stitch significantly increased the strength of the repair and gap resistance.35 Hohendorff et al36 compared fibrin glue versus suture, in a long-term follow-up study, and they reported that the patients in the fibrin glue group had higher modified Thermann scores, equal isokinetic scores, and fewer complications. In this study, the authors concluded that fibrin glue is a suitable alternative to a traditional suture repair.36

**Postoperative Course**

Multiple studies have compared postoperative immobilization versus early functional mobilization, early weight bearing versus nonweight bearing for 6 to 8 weeks, and the need for thromboprophylaxis. The consensus among recent studies is that patients who undergo early functional weight bearing and range of motion have decreased inpatient stays and time off from work, faster return to sports, and a lower complication rate. Kangas et al.21 compared 2 groups, an early motion group versus casting in neutral by placing intraoperative markers. Their results showed greater tendon elongation in the immobilization group and less tendon elongation led to better outcomes. Maffulli et al.22 divided 53 patients, with acute tears repaired with absorbable suture, into 2 groups. One group was immediate weight bearing in an equinus cast for 2 weeks, and then they were placed in a dorsiflexion stop orthosis, and the other group was nonweight bearing with serial casting every 2 weeks with progression to neutral by 6 weeks postoperatively. The authors found the weight-bearing group had higher satisfaction scores, with no increase in isometric testing, and no re-ruptures in either group.22

Suchak et al23,24 published a level 1 study comparing 2 groups of patients. One group was nonweight bearing for 2 weeks and another group was non-weight bearing for 6 weeks. Patients were monitored for compliance by wearing a fixed-hinge AFO with a pressure sensor installed. The author’s results showed that the weight bearing group had better quality of life scores at 6 weeks and 3 months but no difference existed between the groups at 6 months. The authors concluded that early
weight bearing after surgical repair of an acute Achilles tendon rupture improves health-related quality of life at 6 weeks and 3 months with no detrimental effects on recovery with 6 months of follow-up. Ozkaya et al.22 reviewed 25 consecutive patients after open minimally invasive repair with early rehabilitation. The authors reported 1 partial re-rupture and one superficial infection and the patients had a mean AOFAS score of 93. They concluded that open minimally invasive repair of an acute rupture of the Achilles tendon with early rehabilitation provides satisfactory results with low complication rates.

Postoperative thromboprophylaxis is indicated after many lower-extremity orthopedic procedures. Patient’s with ruptures of the Achilles tendon experience a certain amount of immobilization before and after surgical and nonsurgical treatment. Currently, there is no consensus on whether patients should receive thromboprophylaxis.

A level 1 randomized, placebo controlled, double blind study of 105 patients with acute ruptures published by Lapidus et al.17 compared 6 weeks of daily injections of either placebo or 5000 units of Fragmin (Pfizer, New York, New York). The patients were screened for DVTs at 3 and 6 weeks postoperatively by color duplex sonography. Postoperatively the patients were nonweight bearing in a plaster cast for 3 weeks and then were advanced to weight bearing as tolerated in a cast for an additional 3 weeks. The authors found a 34% rate of DVT with 2% being proximal DVTs in the Fragmin group and a 36% rate of DVTs with 6% being proximal DVTs in the control group. No patient in either group was diagnosed with a pulmonary embolism (PE) or demonstrated major postoperative bleeding at the surgical site. Based on the results the authors concluded that DVT is common after surgical repair of the Achilles tendon, and patients should receive effective DVT prophylaxis. The authors found that DVT prophylaxis with Fragmin did not affect the incidence of DVT.37 Another prospective study examined the incidence of DVT in patients with an Achilles tendon rupture. They examined nonoperatively treated and operatively treated patients. They found the incidence of DVT is high after Achilles tendon ruptures and there was no difference in the incidence of DVT in operatively or non-operatively treated patients.38 Based on the results of these two studies the incidence of DVT after an Achilles tendon rupture is high, but neither study reported a case of fatal pulmonary embolus. Currently, there is no scientific evidence to demonstrate a benefit of chemical thromboprophylaxis in reducing the risk of DVT and PE in patients with acute Achilles tendon injuries.

**Surgical Technique**

The patient is positioned prone after administration of either general or regional anesthesia. A longitudinal incision is made on either the medial or lateral aspect of the tendon. If a lateral incision is chosen care must be taken to identify and protect the sural nerve. Length of the incision averages 3 to 10 cm. Once the paratenon is incised longitudinally, the tendon ends are easily identifies. These are then re-approximated with either a Bunnell or Kessler or Krackow type suture technique with nonabsorbable suture. Next, the epitenon is repaired with a cross stitch technique. The paratenon should be repaired if it will be useful to prevent adhesions. Finally, a meticulous skin closure will limit wound complications.39 An alternative method is to perform a percutaneous technique, with a small incision (ranging from 2-4 cm). A few salient points include: the incision should be extended as needed; no self-retaining retractors should be used; and meticulous paratenon and wound closure is essential.

Postoperatively the patient is immobilized in an equinus splint (usually 10°-15°) for 2 weeks. Immobilization may be extended if there is any concern about wound healing. At the 2-week follow-up, full weight bearing is permitted using a solid removable boot. At 6 weeks, aggressive physical therapy is prescribed and the patient uses the boot only for outdoor activity. At 12 weeks postoperatively, no further orthosis is recommended.

**Conclusion**

Acute rupture of the Achilles tendon is a common injury sustained in athletes and middle-aged patients. In some patients age related degenerative changes within the tendon may predispose the tendon to rupture. Certain conditions or drugs may weaken the tendon and make it more susceptible to injury. Achilles ruptures may be missed in an emergency room setting. Studies show successful outcomes with both nonoperative and operative treatments. The decision to pursue operative treatment should be based on patient’s pre-injury functional status and ability to undergo operative treatment. Among operative treatments, studies show a low rate of complications with open, minimally invasive, and percutaneous approaches. Early functional range of motion and weight bearing has been shown to be beneficial compared to a traditional course of casting and nonweight bearing. Deep vein thrombosis is common in these patients postoperatively, but no study has shown whether a postoperative course of pharmacologic thromboprophylaxis is indicated.37,38

**References**


