

Complete Rupture of Large Tendons

Risk Factors, Signs, and Definitive Treatment

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In Brief: Forceful eccentric contraction may cause a partial or complete rupture of a vulnerable large tendon, especially in middle-aged men. When diagnosing a large-tendon rupture, it is essential to rule out a systemic illness or history of local or systemic corticosteroid or anabolic steroid use, because any of these may lead to poor tendon quality and increased risk for rupture. Ultrasound or MRI may help confirm the diagnosis. Treatment is generally surgical with anatomic repair. Return to sport depends on the patient's age, lifestyle, tendon involved, and medical comorbidities.

Tendon injuries are common in people who play sports. The spectrum of potential injury to a tendon is broad, with complete ruptures occurring only rarely. While partial injuries or strains often interfere with athletic performance, complete rupture or avulsion of a large tendon can lead to substantial loss of function, pain, and disability. The large tendons most commonly ruptured include the frequently torn rotator cuff, the pectoralis major, distal

biceps, quadriceps femoris, patellar, and the Achilles.

General local and systemic risk factors that are associated with or directly predispose a tendon to rupture or avulsion are listed in table 1. Many systemic diseases are known to adversely affect tendon quality, and the risk is often compounded by the medications (eg, corticosteroids) used to treat these conditions. Smoking and using anabolic steroids are two controllable lifestyle choices that are risk factors for tendon injury.

TABLE 1. General Risk Factors for Large-Tendon Rupture or Avulsion

| |
|---|
| Chronic hemodialysis with secondary hyperparathyroidism |
| Current fluoroquinolone use |
| Diabetes mellitus |
| Excessive body weight |
| Heavy weight lifting |
| History or current use of anabolic steroid |
| History or current use of local corticosteroid injections |
| Immobilization of a specific joint |
| Inflammatory arthropathies |
| Male sex |
| Muscle weakness and imbalance |
| Smoking |
| Spondyloarthropathies |

In addition to the factors listed in table 1, each large-tendon rupture has unique risk factors, a classic history, key physical examination findings, and specific treatment options. The major large-tendon ruptures also share common features (table 2).

TABLE 2. Common Features of Large-Tendon Ruptures

| |
|--|
| Functional impairment—careful physical examination and evaluation are required |
| Mechanism of injury usually involves a violent eccentric contraction |
| MRI is highly sensitive and specific for diagnosis |
| Patient usually reports feeling and hearing a "pop" |

Possibly associated with systemic disease—a thorough medical history is always required

Predominantly affects men

Treatment is surgical with anatomic repair (only with Achilles tendon rupture is nonsurgical management a reasonable option)

Pectoralis Major Tendon

Rupture of the pectoralis major muscle was first described by Patissier in 1822.¹ An uncommon injury, complete avulsion from its humeral insertion can occur in sports that require forced contraction against resistance, such as weight lifting (eg, bench press) or wrestling.

The pectoralis major muscle is a large, broad sheet of muscle that originates from the midclavicle, sternum, ribs, and external oblique fascia, converges laterally, and inserts on the humerus just distal to the greater tuberosity. This muscle forms the rounded appearance of the axillary fold and functions to adduct and medially rotate the humerus. If the arm is extended behind the plane of the body, the pectoralis major also functions to flex the humerus.

History and mechanism of injury. All reported cases of pectoralis major rupture have occurred in men. Although reported cases are relatively few, the exact incidence of this injury is unknown. In weight lifters, however, this is a well-known injury referred to as the "pec tear." Typically, the tendon is avulsed from its insertion on the humerus during weight lifting, most commonly during the bench press.^{2,3} Other activities during which pectoralis major rupture has been reported include windsurfing, wrestling, gymnastics, rugby, and football.⁴⁻⁸ The common mechanism is excessive tension on a maximally contracted muscle.

Patients are usually in their fourth or fifth decade of life. The injury history is clear, with an audible and painful "pop" and immediate functional disability. Men who bench press heavy weights are at highest risk, particularly if they have used anabolic steroids. Avoiding at-risk activities, such as extremely heavy bench pressing, may minimize risk. Practicing proper training techniques with the use of a spotter for heavy weights is always

recommended.

Physical examination. Clinically, a patient who has a rupture of the pectoralis major reports swelling and ecchymosis in the anterior shoulder and arm region, especially around the tendon insertion on the humerus. Ecchymosis, caused by bleeding from the muscle, can be extensive and may track between tissue planes down the arm and torso. Close observation reveals asymmetry of the axillary folds, with deficiency on the injured side.⁹ The asymmetry can be accentuated by having patients push their palms together in front of their body. A palpable defect is often noted (figure 1), with weakness of internal rotation.

Figures 1,2,4-9: Courtesy of Bernard R. Bach, Jr, MD

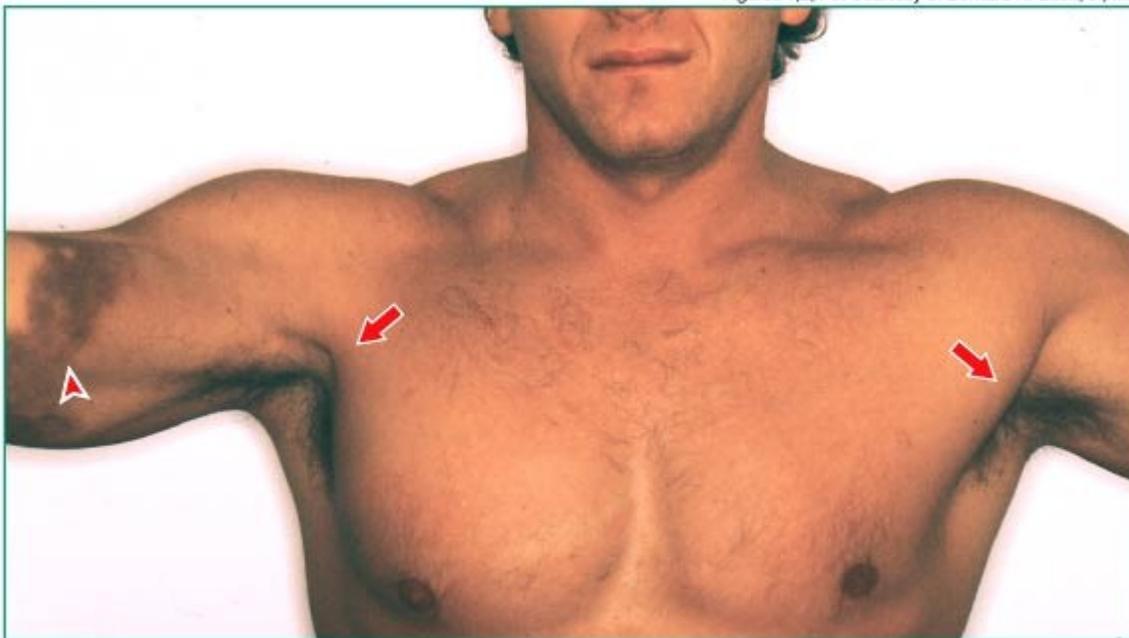


FIGURE 1. Acute pectoralis major muscle rupture in a 35-year-old male weight lifter who was injured while bench pressing. Asymmetry of the axillary region (arrows) and ecchymosis (arrowhead) are evident. He returned to sport 6 months after the rupture was surgically repaired.

Imaging. Ultrasound or magnetic resonance imaging (MRI) of the region can help confirm the diagnosis.

Treatment. To optimize full return of strength and function, the avulsed tendon is surgically reattached at its humeral insertion. Excellent results have been reported for surgical treatment compared with nonoperative treatment.^{4,10,11} Results for patients who had anatomic repairs within 8 weeks postinjury have been

better than later surgical interventions.^{4,10,11} Surgery is performed on an outpatient basis. Through a deltoid-pectoral approach, the tendon and its insertion site on the humerus can both be clearly visualized, and reattachment can be performed with bone anchors or through bone tunnels in the humerus.

Postoperatively, the arm is placed in an immobilizer across the chest for 4 weeks. Gentle range-of-motion shoulder exercises are initiated after 2 weeks. After 4 weeks, the sling is removed and full motion is obtained. Resistive range-of-motion and strengthening exercises are begun at approximately 8 weeks.

Distal Biceps Tendon

Although rupture of the proximal long head of the biceps is substantially more common than rupture of the distal biceps tendon, the functional implications of rupture of the large distal tendon are greater. The first reported case of avulsion of the distal biceps brachii tendon is credited to Starks in 1843.¹² The reported incidence is approximately 1.2 ruptures per 100,000 people per year, but the risk is 7.5 times higher for patients who smoke.¹³

The biceps muscle has two heads, long and short. The origin of the long head is within the shoulder joint, and its function is not exactly understood. The short head originates from the coracoid process. The common insertion is across the elbow at the radial tuberosity. Although often incorrectly thought of primarily as an elbow flexor, the biceps, in fact, is the strongest supinator. Rupture or avulsion from the radial tuberosity, therefore, leads to more supination weakness than flexion weakness.

History and mechanism of injury. Similar to pectoralis major ruptures, distal biceps ruptures occur almost exclusively in men, typically during the fourth to sixth decades of life. In one study¹⁴ of 10 patients, 80% of all ruptures involved the dominant extremity, but in another study¹⁵ of nine patients, 66% had nondominant injuries. Bilateral avulsion is extremely rare, but multiple reports are known.^{12,16,17}

A distal biceps rupture typically occurs during a heavy lift with the

elbow flexed approximately 90° and a sudden contraction of the biceps against a load or resistance. The patient may report experiencing a popping or tearing sensation or sound at the time of injury. Unlike Achilles tendon rupture, which typically occurs a few centimeters from the tendon insertion on the calcaneus, a distal biceps rupture is usually a true avulsion of the tendon from the radial tuberosity.

Preexisting degenerative changes in the tendon at the radial tuberosity may be a predisposing factor to distal biceps rupture. Activities that may increase the risk of injury include waterskiing, heavy weight lifting, snowboarding, or any circumstance that may stretch the biceps tendon during a maximum eccentric contraction^{15,18}

Physical examination. Rupture of the distal biceps is an acute traumatic event. Clinical findings include pain, swelling, tenderness, and ecchymosis in the antecubital fossa. The injured biceps tendon usually is not as palpable as it is on the normal arm during resisted elbow flexion or supination. With the clinician's finger in the antecubital fossa, an intact biceps tendon can be felt during active supination and pronation with the elbow flexed 90°. A bulge in the arm may be visible if the muscle retracts proximally (figure 2). Flexion and supination power loss can be elicited, but the patient may not recognize the deficit, because some flexion strength is maintained by the brachialis and supination by the supinator muscle.



FIGURE 2. A distal biceps rupture in a 47-year-old man who forcefully resisted a heavy load as it fell from a truck. Retraction of the muscle with a resultant bulge (arrow) in the anterior arm is evident. This was surgically repaired.

Imaging. Radiographs are usually unrevealing, and the diagnosis for a complete rupture usually does not require further imaging study. MRI best depicts the defect, evaluates retraction of the muscle, and is helpful in equivocal situations where a partial tear may be detected.

Treatment. Surgery is the recommended treatment for distal biceps avulsions, with the goal of restoring full supination and flexion power through an anatomic restoration of the muscle-tendon unit. Without surgery, up to an 86% loss in supination endurance can be expected, as well as an approximately 40% loss of flexion and supination strength.^{14,19} With operative repair, these deficits can be returned to near normal.

Repair of the avulsed tendon can be accomplished in several ways. Most techniques use either a single incision anteriorly with suture anchors, or two incisions for a repair through a bony tunnel. The elbow is maintained in a splint in flexion and supination. After 6 weeks of protection, a gradual range-of-motion and strengthening program can be initiated.

Quadriceps Tendon

Rupture of the quadriceps tendon occurs approximately three times more often than patellar tendon rupture. The tendon most commonly ruptures transversely about 2 cm from the superior pole of the patella in a degenerative area of the tendon. Bilateral quadriceps ruptures occur in approximately 5% of patients. Spontaneous bilateral ruptures may be associated with systemic illnesses (eg, gout, diabetes) or with anabolic steroid use.²⁰

The quadriceps tendon composes the proximal portion of the extensor mechanism of the knee in a confluence of the vastus medialis, vastus lateralis, vastus intermedius, and rectus femoris muscles. The quadriceps tendon inserts into the patella, a sesamoid bone that acts as a fulcrum to increase the mechanical advantage of the quadriceps in extending the knee (figure 3). The patellar tendon is the distal component of the extensor mechanism that connects the patella to the tibial tubercle. Eccentric contraction can injure either the quadriceps tendon or the patellar tendon, depending, in part, on the degree of knee flexion at the time of injury.

Figure 3: Medical Arts Services, Inc

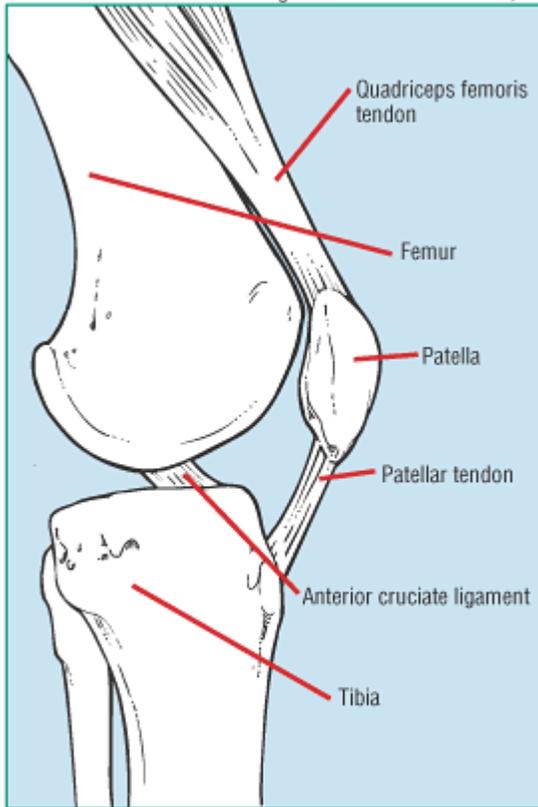


FIGURE 3. The patella is suspended between the quadriceps tendon and the patellar tendon.

History and mechanism of injury. Men sustain quadriceps ruptures more commonly than women, and patients older than 40 years are usually affected. Most patients report a strong reflex contraction of the muscles against body weight with the knee slightly flexed. For example, patients often report that they were going down stairs when they unexpectedly encountered an additional step. They report a "pop" associated with immediate pain, swelling, and an inability to actively extend the knee. Ambulation will be difficult; however, the patient may be able to walk with the leg fully extended.

The patient who has a quadriceps rupture usually comes immediately to an emergency department. Radiographs will often be reported as normal. The patient may leave the emergency room with a knee immobilizer, crutches, and an incorrect diagnosis. An accurate medical history is imperative, with attention to current or past medical problems and medications, prior

surgeries, and injections.

Physical examination. Patients have swelling and ecchymosis at the distal thigh. A palpable defect is felt immediately proximal to the patella (figure 4). The patient is unable to actively extend the knee against resistance—except in some instances when the retinacula on the medial and lateral aspects of the quadriceps tendon are still intact. A careful and complete knee examination should be performed to rule out concomitant ligamentous injury.



FIGURE 4. A palpable defect (arrow) proximal to the patella indicates a quadriceps tendon rupture in the right knee of a 48-year-old man who awkwardly stepped off a curb while carrying heavy groceries. The injury was treated with direct surgical repair.

Imaging. Radiographs often demonstrate subtle findings. Patella baja with a wavy appearance of the patellar tendon may be seen, as well as a small bony fleck from the superior pole of the patella (figure 5). Radiographs should be evaluated for soft tissue swelling consistent with a hematoma. Ultrasound has high sensitivity and specificity for complete quadriceps rupture.²¹ MRI is the most sensitive, specific, and accurate study for the confirmation of quadriceps injury (figure 6).



FIGURE 5. A lateral radiograph of a quadriceps tendon rupture in the same patient as in figure 4 demonstrates patella baja (arrow).



FIGURE 6. Sagittal MRI of a 42-year-old man who fell down stairs shows an acute quadriceps tendon rupture. The lax appearance of the patellar tendon (arrow) and discontinuity of the tendon proximal to the patella (arrowhead) can be seen.

Treatment. Direct repair of the quadriceps tendon to the patella is recommended for most acute ruptures. This is usually achieved through a midline longitudinal incision using heavy nonabsorbable sutures through drill holes in the patella. The retinacula are repaired. Knee range of motion, patella tracking, and the degree of flexion at which significant tension is noted in the repair are assessed intraoperatively. These data will guide postoperative rehabilitation.

The repair must be protected during the early healing phase. A hinged brace (locked in extension for ambulation) is used. Within the range of motion, active flexion that does not apply excess tension on the repair is allowed immediately. A continual passive motion (CPM) machine can also be used. Range of motion is gradually increased over the first 4 to 6 weeks. Ambulation without the brace usually begins after 6 weeks or when the patient achieves greater than 90° of flexion and adequate strength.

For complete ruptures, early repair leads to improved outcomes compared with delayed surgery. Better results are also observed

with younger patients. Overall results following quadriceps rupture are excellent; most patients achieve a normal gait and full strength by 1 year postoperatively.²⁰

Patellar Tendon

Ruptures of the patellar tendon are less common than quadriceps ruptures. The rupture is actually an avulsion that occurs at the distal pole of the patella. The injury is associated with the same activities that predispose an athlete to patellar tendinitis, such as football, basketball, and soccer. Bilateral simultaneous rupture is rare but has been reported.²²⁻²⁶ Most cases occur in patients who have a systemic disease (eg, lupus erythematosus, chronic renal failure, rheumatoid arthritis).

The patella acts to increase the moment arm of the quadriceps. Tremendous loads cross the patella and patellar tendon that may subject the extensor mechanism to forces greater than eight times body weight during athletic activities, especially jumping.²⁷ Histologic examination of torn patella tendons demonstrates underlying tendon degeneration that likely predisposes the tendon to rupture.²⁸ Normal tendons rarely fail during ultimate tensile testing.

History and mechanism of injury. Patellar tendon ruptures occur in younger patients (usually under age 40) compared with quadriceps ruptures (usually older than age 40). Patients usually report a popping or tearing sensation at the time of injury. Because the extensor mechanism is disrupted, as with a quadriceps rupture, the patient reports difficulty with ambulation and an inability to extend the knee. The typical mechanism is an extremely forceful contraction of the extensor mechanism in a partially flexed knee while playing sports or when attempting to prevent a fall.

It is important to obtain a careful surgical history, because prior surgery involving the patellar tendon (eg, anterior cruciate ligament reconstruction using the central third of the patellar tendon or intramedullary nailing of the tibia with disruption of the patellar tendon) may alter the vascularity or the mechanical

strength of the tendon and predispose it to rupture.

The risk of patella tendon ruptures can be minimized by avoiding local corticosteroid injections in patients who have patellar tendinitis or Osgood-Schlatter disease.

Physical examination. The patient who has a patellar tendon avulsion will have pain and swelling with ecchymosis that may track distally with time because of gravity. The patient will not be able to actively extend the knee or perform a straight-leg raise. A palpable defect is usually appreciated (dimple sign), and the patella is high-riding (figure 7). If a large effusion is present and if swelling and pain make the examination difficult, the knee may be aspirated and injected with an anesthetic to relieve pain and allow for a more accurate examination. All other knee ligaments should also be evaluated carefully.



FIGURE 7. Dimple sign of a patellar tendon disruption in a 39-year-old basketball player. The examiner's thumb is at the region where the intact tendon should be. The patient was treated with an anatomic repair of the torn tendon.

Imaging. Radiographs demonstrate patella alta, possibly with a bony fragment at the inferior pole of the patella (figure 8). MRI will reveal the exact site of rupture and provide insight into the degree of underlying tendon degeneration.



FIGURE 8. Lateral radiograph of patellar tendon rupture of the same patient as in figure 7. Note the resulting patella alta (arrow) that suggests the diagnosis.

Treatment. Complete ruptures require surgical repair. Early repairs are technically easier and lead to improved outcomes, because contracture of the extensor mechanism is avoided. The tendon is reapproximated to the inferior pole of the patella through a midline incision and with the use of heavy nonabsorbable sutures placed through drill holes in the patella. The repair may be protected with sutures or wire from the patella to the tibial tubercle, although excellent results have been reported with unaugmented primary repairs.

Postoperative rehabilitation begins with full weight bearing in a hinged knee brace locked in extension. The brace is worn for approximately 6 weeks with removal for use of a CPM machine and range-of-motion and progressive resistance exercises performed under the guidance of a physical therapist.

Achilles Tendon

Spontaneous rupture of the Achilles tendon is a well-documented event that occurs primarily in healthy adults who play recreational sports, such as basketball, volleyball, and various racket sports. Prevalence has been estimated at approximately 0.02% of the population.²⁹

The Achilles tendon is the confluence of the gastrocnemius and soleus muscles. The common insertion is at the posterosuperior calcaneus. This powerful tendon is the primary plantar flexor of the foot and also acts in inversion. Most ruptures take place in an area of decreased vascularity approximately 3 to 4 cm proximal to the tendon's insertion.

History and mechanism of injury. Most Achilles tendon ruptures occur in poorly conditioned men in their third to fifth decade of life who are "weekend warriors" participating in activities that require jumping or forceful plantar flexion. One study³⁰ reported a 14% prevalence of gout and a 7% prevalence of corticosteroid injection history in a cohort of patients who had Achilles tendon ruptures compared with the normal prevalence of only 0.02% to 0.3% in the general population.

As noted with patellar tendon ruptures, histologic evaluation of ruptured Achilles tendons has also revealed significant degenerative changes. The pathogenesis of rupture is probably a combination of an excessive mechanical force (a powerful eccentric contraction) and a vulnerable tendon. The mechanism, regardless of sport or activity, nearly always involves active, often unanticipated, forceful plantar flexion of the foot.

Physical examination. Patients report the sensation of being "kicked" or "shot" in the back of the leg when their Achilles tendon ruptures. Few patients have any prior heel symptoms. Difficulty or weakness with push-off during gait is reported. Careful physical examination will provide the diagnosis, although the correct diagnosis is often missed at the time of initial evaluation.

On examination, a palpable defect is often felt proximal to the

Achilles insertion. Depending on the acuteness of the injury, variable swelling and ecchymosis surround the distal calf. Patients demonstrate weakness in plantar flexion but are still able to do so, because of an intact secondary foot flexors. Positive results on the Thompson test (figure 9) are helpful. This test has 96% to 100% reported accuracy.³¹

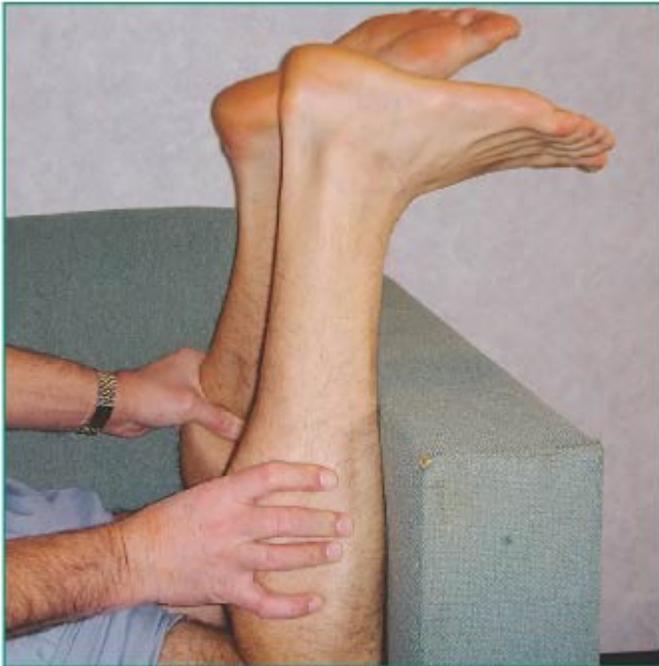


FIGURE 9. The Thompson test is performed with the patient prone and the knees bent 90°. This test suggests a complete rupture of the Achilles tendon when compression of the calf fails to cause plantar flexion of the foot, as is the case with this patient's left foot. The resting position of both feet should be compared.

Imaging. Radiographs are not required, but an MRI is helpful if the extent of the rupture is in doubt.

Treatment. Rupture of the Achilles tendon has good results with both surgical and nonsurgical treatment, so the best method of treatment remains controversial. The advantages of operative treatment include a lower rerupture rate and greater restoration of power, strength, and endurance. The major drawbacks of surgical repair include operative complications, such as wound healing problems and cost.

Conservative treatment involves serial casting of the leg in a below-the-knee walking cast with the foot initially in plantar

flexion. The amount of plantar flexion is diminished every few weeks for 8 weeks, followed by active gastrocnemius strengthening.

Surgical treatment is performed through a longitudinal incision exposing both tendon stumps. An end-to-end repair is then performed using a variety of suture techniques. Tension is set in the tendon to match the contralateral limb. The patient wears a short-leg walking boot with the ankle in 20° of plantar flexion for 2 weeks. Over the next few weeks, the ankle is gradually returned to neutral and weight bearing is increased progressively.

Tending to Tendons

Most patients who suffer large-tendon ruptures are middle-aged men. Poor tendon quality coupled with a forceful eccentric contraction usually leads to the injury. A systemic cause for tendon weakness should be investigated with a thorough history and physical examination. Large-tendon ruptures, except for those of the Achilles tendon, do not heal spontaneously and require surgical intervention to restore function and strength.

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Disclosure information: Drs Flik, Bush-Joseph, and Bach disclose no significant relationship with any manufacturer of any commercial product mentioned in this article. No drug is mentioned in this article for an unlabeled use.

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