FLEX CEUs

Achilles Tendon Injuries & Rehabilitation

Introduction

The Achilles tendon is the strongest tendon in the human body. Along with muscular attachments, it forms the connection from the ankle to the knee and is a crucial structure for ambulation and any activity standing. This makes injury to the tendon cause dysfunction in daily life and can be difficult to recover from. Injuries to the tendon discussed in this course include Achilles tendinitis, tendinopathy, tear and rupture. This course will discuss the diagnosis, differential diagnosis, assessment of and treatment for Achilles tendon pathology. It is important for Physical Therapists and Physical Therapist Assistants to understand the anatomy behind Achilles tendon pathology and evidence-based interventions for best recovery. Best evidence for rehabilitation protocols have changed in the past couple of decades, making it important for clinicians to review this information to best restore their patients to normal function.

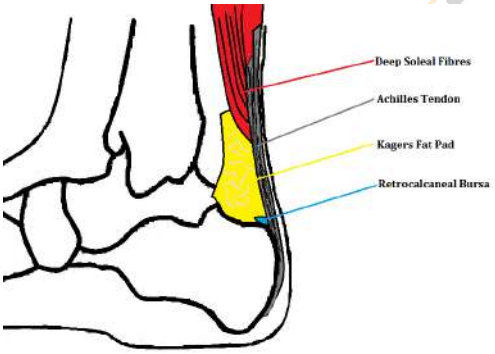
Section 1

This section will discuss important clinical anatomy and function of the Achilles tendon, risk factors and prevalence of pathology to the tendon and differential diagnosis to consider. A clinician should be well aware of the following information in order to effectively recognize and manage patients with Achilles tendon pathology.

Anatomy of Achilles Tendon [1–5]

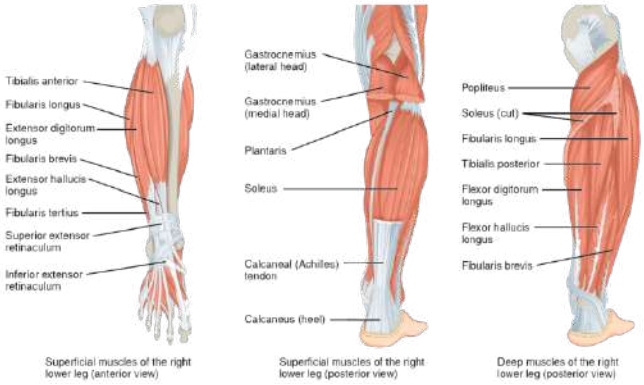
The Achilles tendon is the strongest tendon in the body in terms of tensile force, length and thickness. It is made of dense fibrous connective tissue and 15 centimeters long. The Achilles tendon attaches proximally to the gastrocnemius and soleus muscles and distally to the tuberosity of the calcaneus. Once the muscles are joined, they make up the triceps surae. The gastrocnemius originates from the distal femur and soleus originates from the proximal tibia. Both of these muscles have Achilles tendon fibers that come together to become the Achilles tendon which then attaches at the calcaneus. Muscle fibers twist about 90 degrees where the front fibers of gastrocnemius actually are distally found on the lateral side and the posterior fibers of soleus are distally found on the medial side of the Achilles tendon. The plantaris is a long thin muscle that originates from the lateral supracondylar ridge of the femur and attaches to the inside or medial side of the Achilles tendon. It is considered redundant due to very little contribution to plantar flexion of the ankle. The Achilles tendon is able to glide through fascia and subcutaneous tissue without having a tendon sheath and is surrounded by a paratenon,

a thin membrane with high vascularity. The subcutaneous calcaneal bursa and retrocalcaneal bursa are found posterior to the calcaneus just under skin, and just anterior to the Achilles tendon but posterior superior to the calcaneus, respectively. These bursa act to reduce friction between movement of the skin, Achilles tendon and calcaneus to allow fluid motion. The paratenon will stretch about one inch in any direction assisting with tendon mobility and allows circulation to reach the tendon. This membrane is found surrounding large tendons in the body that do not have a sheath, like the quadriceps tendon. The vasculature is protected by a fat pad called Kager's fat pad, which is found in front of the Achilles tendon. Blood supply for the Achilles tendon includes the posterior tibial artery and the peroneal artery. The posterior tibial artery supplies the tendon with circulation at the ends of the tendon, at the gastrocnemius and soleus and at the calcaneus. The peroneal artery supplies the middle of the tendon but is more poorly vascularized than the proximal and distal portions of the tendon. The gastrocnemius muscle is innervated by the tibial nerve at nerve roots S1 and S2 and the soleus is innervated by the tibial nerve from nerve roots L4 to L5. The Achilles is innervated by the sensory portion of sural nerve and branches of the tibial nerve. The tendon is made of fast-twitch fibers (Type 2), Type I collagen and elastin, with high elasticity facilitating quick rebound. Type I collagen is dense, formed of fibers and is the reason the Achilles tendon has great tensile strength.



https://ankleandfootcentre.com.au/kagers-fat-pad-inflammation

https://www.enjoyshoesshop.com/index.php?route=product/category&cid=180&cname=subcutaneous+calcaneal+bursa+pain



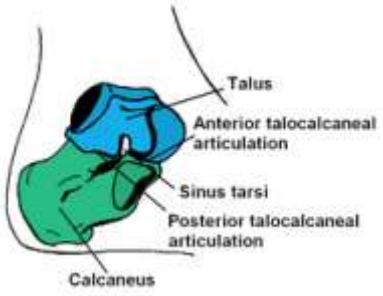
https://courses.lumenlearning.com/ap1x94x1/chapter/muscles-of-the-lower-leg-and-foot/

https://drmikesmith.com.au/ankle/surgery/achilles-surgery/

Anatomy of foot and ankle joints

The foot is broken up into three areas, which are important to understand as they may be affected with lack of mobility or pain secondary to Achilles pathology. The hindfoot, midfoot and forefoot comprise the areas of the foot. The hindfoot is posterior and contains the calcaneus and tarsals. The midfoot contains the navicular, cuboid and cuneiforms as well as the talonavicular and calcaneocuboid joints. The forefoot is anterior and is comprised of the metatarsals, phalanges and sesamoid bones.

1. **Talocrural joint** – articulation from distal tibia and fibula (mortise) and the talus
    a. Connection is via talofibular ligaments and stabilized by talocalcaneal ligaments
    b. This is a hinge joint that allows dorsiflexion and plantar flexion
2. **Subtalar joint** – articulation at three separate areas between talus and calcaneus
    a. Responsible for ankle and hindfoot inversion/eversion and dorsiflexion and plantar flexion



3. Midtarsal joint – comprised of the talonavicular and calcaneocuboid joints allowing joint rigidity to have stable push off function for ambulation and running and inversion/eversion, flexion/extension

    a. Talonavicular joint – articulation between the front aspect of the talus and posterior aspect of the navicular bone

    b. Calcaneocuboid joint – formed between the calcaneus and posterior aspect of cuboid; small movement only occurs at this joint

4. Tarsometatarsal joints (TMT) – separation of midfoot from forefoot and tarsal articulation to the metatarsals

5. Metatarsophalangeal joints (MTP) – condyloid joint between the metatarsal heads to the beginning of phalanges

6. Interphalangeal joints (IP) – hinge joint formed between each phalanx in the toes

Function of Achilles Tendon [2,4]

The Achilles tendon connects the calcaneus to the posterior knee through the gastrocnemius and soleus and allows plantar flexion of the ankle by attaching the tensile tissue of the calf to the heel. As the triceps surae contracts, the forefoot lowers and heel raises, allowing for plantar flexion force which acts through the Achilles tendon. The motion of plantar flexion is crucial for ambulation and other propulsion movements such as running and jumping. When under load, the tendon undergoes a force that is around ten times body weight.

Prevalence of Achilles Tendon Pathology [1,6]

Complete rupture of the Achilles tendon represents around 20% of tendon ruptures in the human body. The Achilles tendon is injured on a spectrum ranging from tear to complete rupture. A tear means some of the fibers of the Achilles tendon are damaged or torn and a rupture is a complete tear of all of the tendon fibers. Achilles tendinopathy accounts for around 60% of injuries, retrocalcaneal bursitis represents 30% of cases and

around 10% of cases are tears of some sort (tear or rupture). Achilles tendon rupture occurs in up to 40 out of 100,000 people.

Activities and Risk Factors [1,3,6–9]

Around 70% of Achilles ruptures happen while a person is active and playing sports involving jumping and movements that change quickly like basketball or football. Achilles tendon injuries occur most often in active males aged 30-50. Athletes of any age are more at risk of Achilles injury than nonathletes. With Achilles tendinopathy specifically, around 35% of injures are sport related leaving the 65% being related to overuse. People are at risk between the 2nd and 4th decades of life from sports injuries and overuse and there is a peak of injuries occurring after the 6th decade due to degeneration of the tendon. The presence of certain diseases may increase the degeneration of the Achilles tendon. These include renal failure, rheumatoid arthritis, systemic lupus erythematosus, gout, collagen disorders, infection, thyroid or parathyroid problems and diabetes mellitus. Patients who have a waist circumference greater than 33 inches, older age, genetics and inherited vascularity of the region, and high abdominal fat percentage are also risk factors. Runners who strike with the heel, genetic predisposure by inheritance or lack of appropriate collagen production and weakness in the hip abductors, external rotators and hip extensors all increase the risk of Achilles tendinopathy.

Differential Diagnosis [7,10–12]

There are a few pathologies which may mimic an Achilles tendon injury. It is important for clinicians to be aware of these conditions and screen for them for a full assessment.

1. **Calcaneal bursitis** can occur at the retrocalcaneal or the subcutaneous calcaneal bursa. Bursitis happens due to overuse causing a repeated force on the bursa and inflammation and pain around these areas. This is common in active people who wear shoes that are too small. Patients will present with pain behind their heel, may have gait disturbance or limp, swelling, and pain increases immediately after starting an activity from resting.

2. **Ankle sprain** is most often sustained by inversion force on the foot which can damage the lateral aspect of the ankle and the most commonly affected ligament, the *anterior talofibular* ligament. The *calcaneofibular* and *posterior talofibular* ligaments may be affected as well. Symptoms are pain, bruise and

swelling and muscle spasming. The severity of the sprain ranges from Grade 1 to 3, 1 being slight tears in the ligament to 3 being complete tear of all the fibers that comprise the ligament.

https://en.wikipedia.org/wiki/Lateral_collateral_ligament_of_ankle_joint

3. **Calcaneus fractures** are typically caused by straight axial force at the calcaneus, making the superior talus bone drive into the calcaneus causing fracture. Common ways to sustain this fracture include a car accident, overuse repetitive injury and falling. A patient will have pain, swelling, bruising and be unable to bear weight. This patient should be referred for imaging.

4. **Calf muscle strain** occurs with overstretch of gastrocnemius and/or soleus muscles which make up the calf or triceps surae. This most often occurs as a sports injury from switching running directions quickly or speeding up or slowing running pace quickly. Patients will have pain, likely swelling and bruising and potential deformity of the calf which is superior to the Achilles tendon.

5. **Medial tibial stress syndrome (MTSS)** is also known as shin splints occurs with pain and irritation along the attachment of the posterior tibialis to the tibia. Symptoms include pain at the lower portion of the medial aspect of the tibia, posteriorly. This can mimic Achilles pathology because pain is often distal rather than proximal and is dull. Patients with MTSS will have pain to being exercise which may go away in the middle of the activity and return as it is ending. If a person does not rest and modify activities, this can result in a stress fracture and pain on the anterior tibia as well as posterior.

6. **Chronic exertional compartment syndrome (CECS)** happens most often in athletes where lower limbs sustain continuous loading like running and skiing. Patients will experience pain with activity and relief with rest. CECS occurs due to

pressure that increases in the bony and fascial tissue in the lower leg which impedes circulation and nerve conduction. Chronic compartment syndrome differs from acute as acute requires immediate surgical decompression due to risk of tissue damage.

7. **Deep vein thrombosis (DVT)** occurs when blood clots form in the deep veins of the extremities and symptoms will be pain, swelling, tenderness and warmth in the lower leg. The risk of leaving DVT untreated is clots travelling elsewhere in the body, including the lungs which can cause a pulmonary embolism and be life threatening. Patients with suspect DVT, which can be evaluated by clinical set of rules called the Wells Criteria (below), should be referred immediately for work up.

Features	Score (points)
Clinical signs and symptoms of DVT	3.0
No alternative diagnosis	3.0
Heart rate >100 beats/min	1.5
Immobilization ≥3 days or surgery in the previous 4 weeks	1.5
Previous DVT or PE	1.5
Hemoptysis	1.0
Malignancy with active treatment in the past 6 months or under palliative care	1.0
Pretest clinical probability	
PE unlikely	≤4.0
PE likely	>4.0

PE = Pulmonary embolism, DVT = Deep vein thrombosis

https://www.researchgate.net/figure/Modified-Wells-criteria_tbl1_309719130

8. **Acute Achilles tendon peritendinitis/paratenonitis** occurs from inflammation of the outside covering of the Achilles tendon resulting in pain and swelling. This is common in patients who are active and sustaining repetitive load to their lower extremities such as running. The tendon covering and surrounding tissues typically are irritated and marked with inflammatory cells. Patients will have pain which is best with rest and worst with activity.

Section 1 Summary

As discussed above, the Achilles tendon and surrounding anatomy are a complex unit that collaborate to allow efficient gait and mobility. Clinicians should be able to recognize differential diagnoses and assess for them, referring when appropriate (in case

of a fracture). General risk factors include genetic predisposition, certain systematic comorbidities, participation in competitive sports and obesity.

Section 1 Key Words

1. **Hinge joint** – synovial joint that allows motion in a singular plane (knee, elbow)
2. **Condyloid joint** – synovial joint that allows motion in two planes by articulation of a convex and a concave surface (metatarsophalangeal joint)
3. **Achilles Peritendinitis (paratenonitis)** - inflammation of the sheath (partenon) of the Achilles tendon resulting in inflammation

Section 2: Achilles Tendonitis, Tendinopathy [13,14]

Achilles tendonitis occurs with inflammation around the tendon and if managed correctly can improve in a couple weeks. Untreated tendonitis can turn into tendinopathy which is chronic and can take up to 6 months to heal from. Achilles tendinopathy is the generally accepted terminology encompassing symptomatic inflammation of the tendon, and is most often when patients will seek medical care.

Pathology [13,15–17]

Achilles tendinopathy occurs when a person has localized pain with loading the Achilles, most often from overuse and occurs most often in the middle aspect of the tendon. Patients with Achilles tendonitis may not yet have significant changes in the structure of the tendon, but those with tendinopathy most often have greater thickness and width of the middle of the tendon. The rest of the tendon is not usually thickened. Although tendinopathy is the accepted term to describe inflammation of the tendon, the pathology will progress from tendonitis to tendinopathy to tendinosis. Tendonitis occurs at the beginning stages and is painful and marked by local inflammation at the tendon. Tendinopathy progresses to midportion thickening of the tendon visible on MRI. Then, tendinosis occurs with further increases in thickness of the tendon. The MRI will show increased thickness in the paratenon and the tendon itself and higher signal will display on the MRI, signs of further degeneration. If the tendon continues to be untreated, tears or rupture can occur due to degeneration and reduced strength of the Achilles. With tendinopathy, oxygen depletion or hypoxia may be evident, along with mucoid degeneration. Hypoxic Achilles tendinopathy further degenerates the tendon by

providing less vascularity and therefore oxygen for optimal function of the tendon. Mucoid degeneration results from the Achilles tendon having too much mucin locally which floods the area and prevents normal function.

Insertional Achilles tendinopathy involves pain and dysfunction where the Achilles tendon attaches to the calcaneus. If left untreated, bone spurs can occur, which calcifies the Achilles tendon insertion. This will result in obvious deformity as shown in the picture below. This is more common in the general population, active or inactive, generally older patients and occurs from chronicity of overuse and degeneration of the tendon.

Midportion Achilles tendinopathy occurs when Achilles tendon fibers degenerate in the middle of the tendon, typically 2 to 5 cm above the calcaneal insertion. This will produce local swelling and tenderness if it progresses and is left untreated. This pathology often occurs in patients that are younger than 60 years old and active.

Insertional Achilles Tendinopathy

Midportion Achilles Tendinopathy

Symptoms [13,14,16]

Achilles tendinopathy at the midpoint of the tendon occurs at a rate of 30% of the population, more specifically in active athletes at 50%. Patients with Achilles tendonitis or tendinopathy will experience pain directly at the Achilles tendon which limits ability to load the tendon normally which will impair activities such as running and jumping. Pain will get worse with loading the Achilles tendon.

Assessment [5,9,13–15,18–21]

Diagnosis of Achilles tendinopathy is typically made from subjective history, patient report and tests to elicit symptoms. Full assessment of the lower quarter is warranted

due to detecting root cause of Achilles pain and other dysfunction that may exist in the lower extremities.

1. Clinical Assessment [5,20,21]

    a. Posture and joint positioning

        i. Spinal posture – take note of lumbar, thoracic and cervical spine, position of scapulae

        ii. Hip height using pelvic landmarks to assess (anterior and posterior iliac spine)

        iii. Knee position

        Knee position is important to assess as the gastrocnemius attaches to the femoral condyles and may affect the muscle length of the medial or lateral head of the gastrocnemius, which attaches to the Achilles tendon.

            1. Genu varum or “bow legged” is when knees are apart compared to the axis of the femur and tibia

                a. Lateral head of gastrocnemius can be lengthened; medial head may be overcompensating and fatigued

            2. Genu valgum or “knock knee” occurs with knees that are close together compared to the axis of the femur and tibia

                a. Medial head of gastrocnemius can be lengthened; lateral head may be overcompensating and fatigued

                b. Genu valgum occurs when the “Q” angle or the angle that forms between the axis of the femur and tibia is greater than 20 degrees in males and 25 degrees in females

            3. Genu recurvatum or “hyperextension” occurs with excess knee extension where the posterior aspect of the knee extends past neutral

a. Can cause lengthened or fatigued and compensating gastrocnemius muscle as it attaches to femoral condyles

iv. Ankle and foot position

1. Pronation

a. Combination of subtalar eversion, forefoot abduction, and ankle dorsiflexion which creates excess weight distribution on the medial aspect of the foot

b. Overpronation can cause medial tibial stress syndrome as the posterior tibialis is often overworked. It can also contribute to Achilles tendinitis or tendinopathy because of the shear force on the tendon and sheath that occurs as the calcaneus everts excessively when the heel is lifted and a person begins forward propulsion of the leg.

2. Supination

a. Combination of subtalar inversion, forefoot adduction, and ankle plantar flexion

b. Too much supination can cause ankle sprain or pain and can cause irritation to the non tensile tissue of the Achilles tension. Through the gait cycle, the calcaneus inverts excessively as the heel lifts and forward propulsion occurs. This causes shear force in the Achilles tendon and sheath.

3. Pes cavus – high arch

a. Occurs as result of longitudinal arch of the foot being raised, first digit being plantar flexed, forefoot being pronated, adducted and in valgus, the hindfoot being in varus

b. Typically from neurological diseases and root cause is weakness in tibialis anterior, foot intrinsic muscles,

and peroneus brevis in respect to the strong posterior tibialis and peroneus longus.

c. Risk of Achilles tendinopathy and rupture because the tendon may lose length over time as it acts as an invertor of the foot rather than the tibialis posterior and anterior

4. Achilles pain in the lateral side can be caused by forefoot valgus of more than 10 degrees

https://www.klmlabstore.com/pronation-supination-s/163.htm

b. Mobility

i. Active range of motion should be tested where the clinician asks to see the patient move in specific directions to assess mobility of lower extremity joints and muscles. These movements should be done bilaterally and measured with a goniometer if they differ bilaterally.

1. Low back – assess flexion, extension, rotation and lateral flexion

2. Hips – assess flexion, extension, internal and external rotation, abduction and adduction

3. Knee – assess flexion and extension

4. Ankle – assess plantar flexion, dorsiflexion, inversion, eversion

ii. Passive range of motion should then be assessed with the clinician stabilizing joints appropriately and pushing the joints to an end feel

or the maximum amount of motion. Either pain or reaching the joint's limit for motion will stop the movement. The clinician should measure with a goniometer and note pain and end feel. The goniometer landmarks for dorsiflexion and plantarflexion are the shaft of the fibula, lateral malleolus and fifth metatarsal.

1. End feel
    a. Bony – hard end feel from bone to bone articulating
    b. Firm – from ligament or muscle stretching, can feel as if there is a slight rebound of tissue at the end range
    c. Soft – restricted by muscle bulk, compression, painless
2. Abnormal end feels are found when the normal end feel of a joint is replaced by another type
    a. Soft may indicate swelling or synovitis
    b. Firm may indicate ligament or muscle shortening
    c. Hard may indicate osteoarthritis, fracture
    d. Empty can indicate abscess, bursitis, fracture or inflammation
3. End feel in ankle and normal degrees of motion are listed below
    a. Plantar flexion – 50 degrees and firm
    b. Dorsiflexion – 20 degrees and firm
    c. Supination – 45 to 60 degrees
    d. Pronation – 15 to 30 degrees
    e. Inversion – 20 degrees and firm
    f. Eversion – 10 degrees and firm

iii. Muscle Length[22]

The general procedure for measuring muscle length is to have a patient completely relax the examined muscle, stabilize joints that the muscle will move and measure the differences bilaterally. Common short muscles in the lower extremity are hip flexors, hamstring and gastrocnemius based on humans sitting more often than in the past.

1. Gastrocnemius – examiner has patient lay prone on a table and dorsiflexes the ankle to measure length of the gastrocnemius bilaterally

2. Hamstring – examiner has the patient lay supine and should flex the hip to 90 degrees then extend knee. The patient's knee should reach near 0 degrees of extension if it has normal length. Short hamstrings are common in patients with lower extremity dysfunction due to compensation for gastrocnemius length or strength issue and pain in the case of Achilles tendinopathy.

c. Strength or Resistive Testing

   i. Strength of manual muscle testing (MMT) graded from 0 at no movement of muscle to 5 at normal strength should be done from the hip to the ankle and foot to test for weakness

      1. It is especially important to determine hip extensor, abductor and external rotation strength as these are often weak in patients with Achilles tendinopathy, leading to dysfunction at the knee or ankle.

      2. Plantar flexion strength

         a. Standing calf raise on one leg

            i. Grade 5 – full range of motion and 5 repetitions

            ii. Grade 4 – full range of motion and 3 repetitions

            iii. Grade 3 – full range of motion and 1 repetition

iv. Grade 2 – full range but without resistance (supine or prone)

v. Grade 1 – movement through some of range with muscle twitch

vi. Grade 0 – no movement or activity

ii. At a minimum, a myotome screen should be done followed by MMT of the weak and/or symptomatic areas in the lower quarter. Myotomes are muscles innervated by a specific nerve that arises from the spinal cord and lower extremity myotome actions are listed below

1. L1/2 – hip flexion
2. L3 – knee extension
3. L4/5 – ankle dorsiflexion
4. L5 – great toe extension
5. S1 – Ankle plantarflexion
6. S4 – bladder and bowel

d. Joint assessment

For all joints listed below, a clinician can examine the articulation by stabilizing one aspect of the joint while mobilizing the other to determine if there are differences bilaterally and if joint stiffness occurs. The clinician should ask for provocation of any symptoms and if the movements are eliciting any pain or other symptoms. It is important to complete interarticular assessment at the foot, ankle and knee as these form the connection from the Achilles tendon and other muscles and joints from the foot to the knee and can have impaired function along with Achilles pathology.

Foot and ankle

1. Talocrural joint

    a. Range of motion taken with knee flexed to avoid contribution of gastrocnemius muscle tightness

b. Normal plantar flexion is 50 degrees and dorsiflexion is 20 degrees

2. Subtalar joint
    a. Range of motion normal values
        i. 45 degrees for flexion
        ii. 70 degrees for extension
3. Midtarsal joint
    a. Talonavicular and calcaneocuboid joints with very little movement
4. Tarsometatarsal joints
    a. Midfoot to forefoot division with little movement, up to 10 degrees of flexion
5. Metatarsophalangeal joints (MTP)
    a. Range of motion normal values
        i. 40 degrees for flexion and extension in digits 2 through 5
6. Interphalangeal joints (IP)
    a. Range of motion normal values
        i. 1st digit – flexion 90 degrees and extension is 0 degrees
        ii. Digits 2-5 flexion 35 degrees and extension 0 degrees

Knee

1. Tibiofemoral joint articulates between the proximal femur and distal tibia and is a hinge joint responsible for flexion and extension of the knee

2. Patellofemoral joint occurs because the patella within the quadriceps tendon forms a joint between its posterior surface and the femur

3. Range of motion normal values for flexion is around 140 degrees and extension should get to 0 degrees. The tibia will also rotate when the knee is flexed and will rotate when the knee is extending to a small degree to contribute to knee stability. This is called the screw home mechanism

e. Gait Assessment[23,24]

Gait assessment is important with any lower extremity pain or pathology. With respect to Achilles tendinopathy, deviations can lead directly to Achilles injury and Achilles injury can lead to gait impairments. This section will discuss normal gait pattern and deviations a clinician may observe with Achilles pathology.

i. Stance phase- 60% of gait cycle time

1. Heel strike or initial contact

a. Normally

i. 30 degrees hip flexion

ii. Full knee extension to slight knee flexion

iii. Ankle dorsiflexion to neutral then plantar flexion

1. Plantar flexion regulated by eccentric elongating of the tibialis anterior

b. Impairments related to Achilles pathology

i. Gastrocnemius or soleus tension and weakness of the tibialis anterior can restrict the ankle from dorsiflexing fully

2. Loading Response

a. Normally

i. Foot pronates and ankle plantar flexion reaches 15 degrees

ii. Hip gradually extends

iii. Knee to 20 degrees flexion

b. Impairments related to Achilles pathology

i. Ankle eversion is associated with Achilles tendinopathy due to tendon being pulled medially with associated microtrauma and inflammation

3. Midstance

a. Normally

i. 10 degrees of hip flexion to extension

ii. Knee flex at peak then extends

iii. Ankle supination and dorsiflexed by contraction of gastrocnemius and soleus

b. Impairments related to Achilles pathology

i. Overpronation of the foot can lead to the Achilles tendon being drawn medially. This can lead to trauma to the tendon and is common with tendinopathy due to inflammation that results.

4. Heel Off

a. Normally

i. Around 12 degrees hip extension, then moves to flexion

ii. Knee flexion minimal (5 degrees)

iii. Ankle supination then plantar flexion

b. Impairments related to Achilles pathology

i. Ankle pronation can lead to medial pull of the Achilles tendon, ankle supinating too much can lead to a lateral pull of the Achilles tendon, causing inflammation and microtrauma

ii. Swing phase- 40% of gait cycle time

1. Toe Off

a. Normally

i. Less hip extension

ii. Knee flexion to 40 degrees

iii. Ankle plantar flexion at 20 degrees

b. Impairments with Achilles pathology

2. Early Swing

a. Normally

i. Hip extension to 10 degrees, then flexion

ii. Knee to 50 degrees of flexion

iii. Ankle from 20 degrees plantar flexion then do dorsiflexion and then neutral

b. Impairments related to Achilles pathology

i. Gastrocnemius tension and over activation can prevent dorsiflexion, leading to inflammation and irritation at the Achilles tendon

3. Mid Swing

a. Normally

i. Hip flexion to 30 degrees

ii. Ankle dorsiflexion by tibialis anterior

iii. Knee flexion to 60 degrees, then to 30 degrees of flexion

b. Impairments related to Achilles pathology

i. Ankle dorsiflexion not to full range with gastrocnemius tension and/or tibialis anterior weakness, preventing the foot from enough dorsiflexion to clear foot in some cases

4. Late Swing

a. Normally

i. Hip flexion of 30 degrees

ii. Full extension of knee

iii. Neutral ankle

b. Impairments related to Achilles pathology

i. Possible pain with movement, but neutral ankle typically is achievable with Achilles tendinopathy

f. Special Tests[13,14]

i. **Single leg heel raise** is a manual muscle test for strength of plantar flexion. The clinician would instruct the patient to stand on one foot with the other foot in the air, holding onto a steady object and to raise up on one heel. If a patient has Achilles tendinopathy this movement will be painful right over the Achilles tendon and potentially not possible if the tendinopathy is very chronic.

ii. **Hop test** – the patient is instructed to jump as far as they can on one leg and land without losing balance. If there is greater than a 10% difference than the other limb, this is positive for a lack of power on the affected limb.

iii. **Royal London Hospital Test** – the patient begins in the prone position and the clinician palpates for a tender part of the Achilles (either right at the insertion for insertional tendinopathy and somewhere between 1 to 2 inches (2 to 5 cm) proximal to the calcaneus for midpoint tendinopathy). The patient then moves to full dorsiflexion as the clinician continues to palpate the tender

spot, then to full plantar flexion. This test is positive for tendinopathy if the pain dissipates in full dorsiflexion and returns during plantar flexion

iv. **Painful arc sign** – the patient begins in prone with ankles over the table and the clinician begins to palpate from calcaneal insertion proximal up the tendon looking for an area of increased tendon thickness or swelling. The clinician keeps holding on to the area with greater thickness while the patient dorsiflexes and plantarflexes the ankle. With tendinopathy, the area of swelling will move with plantar and dorsiflexion. If the area is immobile, the clinician can expect tendon sheath pathology.

g. **Palpation** is a useful tool in discovering tendon thickness and provocation of symptoms to assist with diagnosis. Clinicians should palpate or feel for tenderness in the gastrocnemius and soleus muscle bellies from origin to insertion and other muscle bellies of the lower extremity if the patient reports pain or dysfunction in any area. The gastrocnemius, soleus and other lower extremity muscles may overcompensate for Achilles tendon pain, causing taut tissue with trigger points that may respond well to stretching or soft tissue mobilization.

h. Outcome Measures

i. Patients will have pain when Achilles tendon is palpated along with possibility of slight increase in tendon thickness.

ii. **Foot Posture Index (FPI)** is an outcome measure useful in determining foot position including whether excess pronation or supination is present.

1. The clinician observes and palpates the foot and rates position on a scale of -2 to 2, 0 being neutral, higher scores being pronated and lower scores being supinated

iii. **Victorian Institute of Sport Assessment-Achilles (VISA-A)** – self report outcome measure most effective for determining pain and lack of mobility from Achilles pathology

1. 8 questions, and a lower rating means more disability, 100 being a score with no problems related to Achilles tendinopathy

iv. **Lower Extremity Functional Scale (LEFS)** – self report outcome measure used to capture a patient's participation and activity restrictions with Achilles tendinopathy in a series of 20 questions rating difficulty of activities from 1 being unable to perform to 5 being no difficulty. Higher scores (up to 80) indicate less disability

v. **Foot and Ankle Ability Measure (FAAM)** - self report outcome measure used to capture a patient's participation and activity restrictions with Achilles tendinopathy

1. Subscales of Activities of Daily Living (21 questions) and Sports (8 questions) subscales
2. Difficulty of items scored on 0 to 4 scale 0 being unable to perform and 4 being no issue performing
3. 84 is maximum score for ADL subscale and 32 for sport subscale
4. 100% means no dysfunction and 0% means complete dysfunction as the scores are converted to percentages

2. Advanced Imaging[13,25]

a. Imaging is a common tool used for diagnosis but is not as necessary as with a tear or rupture of the Achilles tendon. Diagnosis is typically made on the clinical characteristics of localized pain, tendon thickening and pain with loading the foot and ankle. Magnetic resonance imaging (MRI) can be useful to differentiate soft tissue from bone and can detect local increased thickness of tendon, abnormalities in tendon shape and any abnormalities in blood flow to the area. In a normal MRI, there will be little signal or color change on the image and with a pathological MRI, there will be higher signal or color contrast revealing abnormalities. Imaging is commonly inaccurate as it will also detect these changes in normal asymptomatic Achilles tendons around one quarter of the time. MRI is useful in ruling out other conditions besides tendinopathy including bursitis, slight ruptures, paratendonitis and tumors. Many practitioners

will assess the Achilles tendon with ultrasound due to less cost and more readily available than MRI. This is less accurate and the practitioner can only view a from the posterior aspect of the ankle, making MRI the best imaging strategy.

Prognosis [13,26]

It is predicted that 80% of patients will make a full recovery from long lasting symptoms of Achilles tendinopathy at 6 months to one year. Other patients may need to be operated on or still have pain and dysfunction at follow up. At eight years of follow up about 95% of patients will have no symptoms except pain occasionally with intense exercise. Around 40% of patients with Achilles tendinopathy will have symptoms in their asymptomatic Achilles at eight years of follow up.

Rehabilitation Timeline and Protocol [9,22,27–30]

1. Eccentric Loading Program
    a. Nearly all studies support eccentric exercise for alleviating Achilles tendinopathy. The protocols between studies vary quite a bit as well as patient compliance with eccentric exercise, which can be very low.
    b. Prior to recent evidence, it was thought that eccentric exercise needed to occur one to two times per day. However, patients can gain equal results with two sessions per week, especially when combined with other interventions.

Below is the commonly accepted Achilles tendon eccentric loading program

a. *Week 1-2* – all activities are difficult; exercises done once per day
    i. Ankle pumps
    ii. Heel raises on even ground bilaterally at 3 sets of 15 repetitions
    iii. Heel raises on one leg on even ground at 3 sets of 10 repetitions
    iv. Seated heel raises at 3 sets of 10
    v. Eccentric heel raises on even ground (3 sets of 10)

1. Instruct patient to move into plantar flexion then slowly to dorsiflexion, stopping if there is severe or moderate pain

Goal of this phase is to understand pain with movement for the clinician and patient and to start mobility.

b. *Week 2-5* – exercise pain, stiffness in morning and pain with heel raise; exercises done once per day

   ii. Bilateral heel raise at edge of step at 3 sets of 15

   iii. Unilateral heel raise at edge of step at 3 sets of 15

   iv. Seated heel raises at 3 sets of 15

   v. Slow and controlled eccentric heel raises at edge of step at 3 set of 15

   vi. Fast heel raises moving from eccentric to concentric quickly on even ground at 3 sets of 15

Goal of this phase is to begin the strengthening process.

c. *Weeks 3-12 and beyond* – can progress to this if pain is absent at tendon insertion and should be completed daily with more load 3 times per week

   i. Unilateral heel raise at step edge with weight (progressive as tolerated) at 3 sets of 15

   ii. Heel raises seated at 3 sets of 15

   iii. Eccentric heel raises on step edge standing with weight at 3 sets of 15

   iv. Fast heel raises moving from eccentric to concentric quickly on even ground at 3 sets of 20

   v. Complete plyometric training and return to sport gradually

Goal of this phase is to progress strengthening and begin return to sport (running)

d. *3-6 months* – patients with almost absent symptoms at rest and with sports and resolving morning stiffness; should be completed 2-3 times per week

    i. Unilateral heel raise at step edge with weight (progressive) at 3 sets of 15

    ii. Eccentric heel raise at step edge with weight (progressive) at 3 sets of 15

    iii. Fast heel raises bilaterally on even ground at 3 sets of 20

Goal is maintenance of symptoms and prevention of recurrence of symptoms.

Another 12 week eccentric program originally proposed by Alfredson et al:

a. Standing with knee extended complete 3 sets of 15 repetitions daily with heels over a step edge

    i. Progress to unilateral when almost no pain

b. Standing with knee flexed complete 3 sets of 15 repetitions daily with heels over a step edge

    i. Progress to unilateral when almost no pain

c. Instruct the patient to complete all above exercise with progressive weight once they are able to complete all without pain without weight; progress to 3 sets of 15

d. While going through the protocol, patients can complete normal exercise routines even with pain as long as it is not debilitating and can even do light jogging with just mild pain

2. Heavy load slow speed

a. Studies have found that high weight and slow speed (eccentric and concentric movement) helps reduce symptoms of chronic midportion Achilles tendinopathy over time, even as effectively as an eccentric exercise protocol.

b. Protocol

i. Seated with knee flexed working on calf raises through full ankle range of motion bilaterally

ii. Knee extension with weight on shoulders through full ankle range of motion bilaterally

iii. Knee extension on leg press machine through full ankle range of motion bilaterally

These exercises should be completed at the full available range of motion and progressed from 3 sets of 15 to 4 sets of 6 over 12 weeks. It should take a full six seconds to range through full motion in the ankle. These exercises were repeated three times per week. After 3 months and one year of follow up, patients had greater than a 95% satisfaction rate, more normalized tendon width and significantly reduced VAS pain rating

3. Manual Therapy [22]

Completed to reduce stiffness and improve pain and dysfunction in a joint or soft tissue

a. Joint mobilization

With joint mobilization, grades are measured from 1 to 5. Grade 1 is a small movement slightly into the range of motion. Grade 2 is a large movement in the available range of motion. Grade 3 is a large movement into resistance of tissue. Grade 4 is a small movement into resistance of tissue. Grade 5 is a manipulation with a quick thrust at the end of the joint mobility. Clinicians should always measure motion pre and post treatment to examine if the mobilization helps gain more mobility in the joints being treated.

i. *Talocrural joint thrust manipulation* – the examiner will instruct the patient to lay supine on a treatment table with heel slightly off the edge of the table. The leg not receiving the manipulation should be stabilizing the treatment, with knee in flexion

and foot and heel on the treatment table. The clinician will hold onto the mid foot with force directed at talus, with intertwined fingers on the superior aspect of the foot, thumbs on the plantar aspect. The clinician will then complete distraction as pre manipulation mobility, may slightly evert or invert the ankle feeling the highest stiffness in movement. Once the highest stiffness is found, the clinician will direct movement pulling the ankle into dorsiflexion and inversion or eversion, take up all slack in tissue resistance and complete a thrust. This can be repeated, most commonly three times a session.

1. Ankle dorsiflexion and/or eversion and inversion should be measured pre and post treatment as a measure of improvement.

ii. *Subtalar lateral glide* – Clinician instructs the patient to lay on a treatment table on their symptomatic side. Stabilizing the mortise or distal tibia with one hand, the clinician will place their other hand over the calcaneus and mobilize directly inferior and superior, perpendicular to the treatment table

1. Pre and post measurements should be ankle eversion and inversion as this mobilization is for improving subtalar mobility

iii. *Talocrural Dorsiflexion Mobilization with Movement* – The clinician will instruct their patient to stand on the treatment table carefully with their symptomatic foot forward facing the clinician, in a lunge stance. The clinician will wrap one hand around the talus, just distal to the distal tibia and fibula. The clinician will then instruct the patient to dorsiflex ankle in an active lunge without lifting the heel superiorly. During this movement, the clinician will posteriorly

mobilize the talus by applying directly parallel force to the treatment table. This can be repeated for two to three sets of 10 repetitions.

1. Clinicians should measure ankle dorsiflexion pre and post mobilization session to determine differences in talocrural mobility

b. Soft tissue mobilization

Completed to reduce trigger points or tense spots in muscle with bound up tissue. The clinician will have the patient lay in a comfortable position on a treatment table with the treating muscle accessible. The clinician will generally progress from gentle mobilization or massage and progress to mobilization along the muscle belly, using different strategies such as pin and stretch or even contract-relax stretching to allow bound up tissue in muscles to relax. Pin and stretch occurs when a clinician pins or holds soft tissue down and lengthens the rest of the muscle. Contract relax is a proprioceptive neuromuscular facilitation stretch to gain more soft tissue mobility by having the patient contract the opposing muscle and stretch the targeted muscle.

i. Gastrocnemius

1. The clinician has the patient lay prone and should begin at the medial and lateral head of the muscle attaching at the distal femur, searching for trigger points and tense parts of the muscle belly. To begin, the clinician should use most of their hand with a wide surface area to provide patient comfort. Working along the length of the muscle down to where the Achilles attaches, the clinician should massage and mobilize until tension is relieved or at least lessened. The clinician should measure ankle dorsiflexion pre and post to see if the mobilization increased mobility.

ii. Hamstrings

1. The clinician should instruct the patient to lay prone and search for taut areas and trigger points by working from

proximal attachment of the ischium to the distal attachment at the distal femur and iliotibial band at the head of the fibula. The taut and bound up muscle should be massaged within a patient's pain tolerance to resolve tension and improve biomechanics of the hamstring (semitendinosus, semimembranosus and biceps femoris).

iii. Distal Quadriceps

1. The clinician will have the patient lay supine and search for taut or bound up muscle from the mid thigh down to the distal quadricep (vastus medialis on the medial aspect of the knee, vastus lateralis on the lateral aspect of the knee, vastus intermedius between the two, and rectus femoris superficial to the vastus intermedius, all attaching at the patellar tendon). Bound up muscle in this area can affect the tracking of the knee and the biomechanics at the ankle due to gastrocnemius attachment to the knee.

4. Stretching

   a. Plantar flexor stretch performed with knee in flexion or extension at 3 sets of 30-60 seconds. This stretch will allow further dorsiflexion if impaired in patients with Achilles tendinopathy

   b. Step plantar flexion stretches

      i. Patient is instructed to have their heel off the end of the step as they hold a stretch for around 20 seconds

      ii. This is repeated for 3-6 sets

      iii. Progression is bilateral to unilateral of the involved side over weeks

      iv. At 12 weeks patients have around a 4.5 reduction in pain on the visual analog scale of pain which is scored from 0 to 10

5. Patient education is a crucial part of rehabilitation from any injury or pathology. Clinicians should educate patients on the timeline for recovery, adjusting risk factors if there are any, including shoe choice and body mass index as well as most useful interventions in reducing symptoms.

a. Activity modification – evidence suggests that total rest besides participation in rehabilitation is not helpful in returning to the prior level of function the fastest. With chronic tendinopathy, patients should be educated to continue activities within pain tolerance.

6. Iontophoresis – application of low-level electricity via negatively and positively charged electrodes with medication, placed over symptomatic areas. It is useful in reducing pain and inflammation and evidence supports its use in patients with acute midportion tendinopathy. The most common steroid to use for medication is dexamethasone due to its anti-inflammatory nature and pain control for connective tissue and muscular symptoms.

7. Taping – evidence does not support kinesiotape or flexible elastic tape for improving pain and symptoms but clinicians may try rigid tape to lessen the amount of tautness on Achilles. This will allow for pain control and deceased strain on the tendon with activity

8. Neuromuscular reeducation – exercises to encourage activation of muscles that are not functioning properly in the correct sequence. This would likely target the gastrocnemius, soleus, hamstrings, quadriceps and hip stabilizers (gluteus medius). Clinicians should use tactile stimulation, cueing and possibly proprioceptive neuromuscular facilitation targeting activation of lower extremity muscles to encourage correct pattern of mobility

9. Dry needling – Newer evidence[31] supports ultrasound guided decompression of areas around the paratenon followed by dry needling and an eccentric loading program. Decompression was performed once per week for 6 weeks and dry needling targeted taut muscles and neovascular areas. In this study just about 90% were able to return to sport one year after this protocol. This protocol works best for chronic tendinopathy with increased tendon thickness. Dry needling alone is not effective long term for resolving symptoms of chronic Achilles tendinopathy but combined with other treatments is effective.

Evidence is Outdated or Contradictory

1. **Night splints** were once used to hold the Achilles and calf taught at night in hopes of gaining mobility in these tissues. Compared to other interventions like eccentric exercise, night splints make no significant improvement in patients with Achilles tendinopathy. Night splints are more useful in patients with neuromuscular conditions, such as cerebral palsy.

2. **Heel lifts** are also an outdated treatment strategy for Achilles tendinopathy as some evidence suggests improvement with heel lifts and some suggests no benefit of using a heel lift. Again, eccentric exercise and other interventions are more effective. Heel lifts do help alleviate symptoms in some patients but should never be a focus of treatment.

3. **Foot orthoses** were once recommended for active patients to optimize ankle and foot position during activities such as running and jumping. Evidence suggests that patients will have the same outcome with or without an orthoses as long as they are completing eccentric loading protocol and other helpful interventions for Achilles tendinopathy. Therefore, clinicians should not recommend orthoses as a main part of treatment unless patients may benefit from orthoses for other reasons such as extreme foot pronation or modifiable factors from the Foot Posture Index.

4. **Low level laser therapy (LLLT)** – diode from a laser is applied over the symptomatic area which effectively lessens swelling, inflammation and allows healing with pain reduction. It used to be recommended for clinicians to try, however evidence suggests that it is often no better than a placebo laser. Clinicians should complete active mobility and treatments with better evidence than LLLT.

Other Treatments [26]

1. **Extracorporeal Shock Wave Therapy** – delivery of energized acoustic shock waves to damaged tissues

    a. Predicted benefit is greater in patients with symptoms for less than one year especially if patients are over 60 years old

    b. After four months there was a 52% rate in alleviating symptoms of midportion Achilles tendinopathy and a 65% complete recovery in patients with insertional tendinopathy

    c. Parameters that are effective include an average of 2000 Hz for pulses, 27 for pulse frequency, and 2250 total pulses, completed 3 times per week

2. **Platelet Rich Plasma (PRP) Injections** – Platelets of typically the same patient are injected near the Achilles tendon in an effort to stimulate healing of the tendon. Despite many trials and systematic reviews testing the effectiveness of PRP,

evidence does not support use of PRP for improvement of symptoms and dysfunction for patients with Achilles tendinopathy. Many studies found no difference in patient outcomes with or without the PRP injection.

3. **Corticosteroid Injections** [32] – anti-inflammatory steroids that are injected directly near the Achilles tendon are effective at least in short term follow up. Patients who benefit from corticosteroid injections typically did not improve with exercise only but when combined with injections, improve significantly compared to exercise alone. Therefore, clinicians should refer out to consider additional pain relief for their patients if no notable improvement is seen in around one – two months. Injections in tendons are done more sparingly than joints due to a steroid's nature of weakening connective tissue over time. However, a corticosteroid injection can help patients have immediate pain relief, allowing them to functionally use the Achilles tendon and potentially complete rehabilitation more effectively. This increases outcomes as well.

Section 2 Summary

Achilles tendonitis and tendinopathy are typically diagnosed by clinical presentation, symptoms, and special tests including the single leg heel test, hop test, Royal London Hospital test, and painful arc test. Tendinopathy is the more commonly used term in the literature to encompass inflammation and dysfunction of the Achilles tendon as terms like "tendonitis" and "tendinosis" were being used interchangeably leading to confusion. Literature supports eccentric strengthening, stretching and manual therapy for rehabilitation interventions along with adjunct of things like plasma and corticosteroid injections.

Section 2 Key Words

1. **Mucin** – gel like substance that forms mucus if combined with other materials such as salts; in this case floods the Achilles tendon area preventing normal anatomy and function

2. **Genu varum** – position of the knee where increased space exist between knees than between the femur and tibia of each leg (bow legged)

3. **Genu valgum** – position of the knee where less space exists between the knees than between the femur and tibia of each leg (knock kneed)

4. **Genu recurvatum** – knee position posterior to the normal axis of the knee and lower extremity (hyperextension)
5. **Pes cavus** – foot position where longitudinal arch is heightened resulting in high arch.

Section 3: Achilles Tendon Tear

An Achilles tendon tear is the stage between tendinopathy and full rupture and is often misdiagnosed as advanced Achilles tendinopathy. This section will discuss tears as a separate entity, including symptoms, assessment and treatment.

Pathology [33]

An Achilles tendon tear occurs when part of the tendon is frayed, damaged or torn. It occurs suddenly, not gradually as with tendinopathy. Tears are often related to tendinopathy in that they more commonly occur over portions of the tendon where midportion tendinopathy is or was present in the past. This is due to that part of the tendon being worn down and inflamed, predisposing it to tearing. Steroid injections from treatment of Achilles tendinopathy can also predispose the tendon to tearing due to degenerative properties of steroids on connective tissue. Near half of patients with Achilles tendon tears have had a steroid injection near the tendon in the past. Insertional ruptures near the calcaneus can occur from bony protuberance wearing down the tendon. The most common portion to tear is mid tendon up to 5 centimeters above the insertion at the calcaneus. Achilles tendon tears are either acute, with recent splitting of collagen deposition or chronic, with vasculature in close proximity to the tendon in an attempt for healing.

Symptoms [33]

Patients will report common symptoms with Achilles tendon tear. These are specific pain at a point in the tendon, limping, dysfunction and difficulty performing running and jumping activities. Tears occur most commonly in young males who are athletes. Partial tears are uncommon in elite athletes, who more commonly fully rupture the Achilles tendon.

Assessment [33]

1. Clinical
    a. Assessment will involve the same process as Achilles tendinopathy in Section 2. However, patients will have more direct pain with palpation and local tendon thickness than with Achilles tendinopathy. Clinicians will perform a full lower quarter assessment including but not limited to joint mobility, muscle strength and length surrounding the Achilles tendon, gait assessment, posture and palpation.
2. Advanced Imaging
    a. Ultrasound
        i. Useful in differential diagnosis of rupture and partial tear with above 90% accuracy in some studies. However some studies question the accuracy of differences between partial tear and tendinopathy as it is common for both diagnoses to show tendon thickening, new vascularity and echo pattern that is irregular.
    b. Magnetic Resonance Imaging (MRI)
        i. Tear is signified by increased thickness of the Achilles with increased signal intensity of T1 and T2 due to fluid being detected, which is usually associated with inflammation
        ii. MRI is near 100% accurate while ultrasound is up to 20% accurate in diagnosing partial Achilles tendon tears

Prognosis [34]

There are several factors that affect the healing time for an Achilles tendon tear. These include age, how severe the tear is and level of fitness. With a partial tear recovery timeline ranges from just two weeks to three months with or without wearing a walking boot depending on severity of the tear. Patients who successfully modify activities and complete a physical therapy protocol as listed below tend to recover more quickly with higher levels of gastrocnemius and soleus strength and normalizing ankle dorsiflexion range of motion.

Rehabilitation Timeline and Protocol [33]

Suggested rehabilitation for Achilles tendon partial tear is similar to that of Achilles tendinopathy, with a few differences. It is not studied as thoroughly as tendinopathy rehabilitation because partial tears are commonly misdiagnosed as tendinopathy. For an overview, initially clinicians will recommend rest and activity reduction, with pain relieving strategies such as soft tissue mobilization, joint mobilization, ice and heat application (see Section 2). As the patient progresses with tolerating nonresistive exercise, the clinician can recommend progression of weight bearing progressive tendon loading. This will include calf raises at first, progressing to bilateral and unilateral eccentric calf raises.

1. First six weeks
    a. Heel lifts at up to 2 cm may be used to take pressure off partially torn tendon
    b. Clinicians should instruct patients to not stretch the gastrocnemius or soleus and that walking will not be harmful at this stage.
2. Seven weeks to three months
    a. Heel lifts up to 1 cm may be used to take pressure off partially torn tendon
    b. Recommended exercises at this stage are similar to those for Achilles tendinopathy
        i. Calf raises sitting at 3 sets of 15
        ii. Gradually progress to bilateral standing, then single leg calf raises from even ground at 3 sets of 15
    c. Patients may have minimal to moderate levels of pain in this stage and should be instructed that they are able to complete low impact activities like swimming, bicycling and walking
3. Beyond 3 months or when pain is absent
    a. No heel lifts recommended
    b. Complete eccentric protocol for gradual strengthening of Achilles tendon under load

i. Eccentric calf raises from step at 3 sets of 15 progressing from bilateral to unilateral when pain free

c. Patients can also return very gradually to prior activity, only when pain free to avoid recurrence

4. See Section 2 for strategies to manage pain and lack of mobility in the foot and ankle joints, gastrocnemius and soleus and different modalities that assist with recovery. Patients with partial tears will benefit from interventions such as subtalar joint mobilization, gastrocnemius soft tissue mobilization and exercises to improve weaknesses in other lower extremity muscles surrounding the hip and knee to restore optimal function. Soft tissue mobilization is appropriate within the first couple weeks of partial tear. Low grade (1 and 2) mobilizations for improving ankle dorsiflexion and eversion should be used initially with progression to grade 3 through 5 to prevent and treat lack of ankle mobility.

Surgical Repair

Surgery has mixed outcomes for Achilles tendon partial tear, as conservative management is often just as effective with a shorter recovery period. Patients should be referred for surgery if and/or when they have had poor outcomes with 3-4 months of conservative management. Surgery is more effective for patients with Achilles tendon insertional partial tear than midportion partial tear.

Surgical options are as follows.

1. Tendon removal with suturing for midportion tear

    a. Surgeon removes the degenerated part of the tendon, suturing the remaining portion medially to laterally

    b. Mixed outcomes with anywhere from two thirds to 80 percent of patients being satisfied.

2. Calcaneoplasty with insertional tendon partial tear

    a. Calcaneoplasty is a procedure where a surgeon removes bone prominence from the calcaneus with insertional tendinopathy. The surgeon then reattaches the Achilles to the calcaneus.

b. This repair has good to excellent results for patients with insertional partial tears

Section 3 Summary

Achilles tendon partial tears are often misdiagnosed as Achilles tendinopathy. It is important for clinicians to recognize the differences and refer for imaging if necessary to confirm diagnosis. Rehabilitation strategies are similar to that of tendinopathy, but patients may benefit from heel lifts to offload the partially torn tendon while it recovers.

Section 3 Key Words

1. **Eccentric loading** – in the context of Achilles rehabilitation eccentric loading is a stage of exercise where the patient progressively and slowly moves the ankle from plantar to dorsiflexion in an effort to increase tendon durability and ability to load it without tear or rupture
2. **Calcaneoplasty** – insertional Achilles tendinopathy surgical management where part of calcaneus is removed and Achilles is reattached to the calcaneus.

Section 4: Achilles Tendon Rupture [1]

Achilles tendon ruptures are the most common full thickness tendon tears in the human body, representing one-fifth of tears. They occur from sports injuries most often in middle aged men. Patients will experience poor ability to walk, run and will have pain with weight bearing after a rupture. There are conservative and operative management strategies for treatment, which are outlined below.

Pathology [35]

Achilles tendon rupture involves fully tearing the collagenous fibers of the Achilles tendon, either at the midpoint or the insertion of the tendon at the calcaneus. The paratenon, the vascularized tendon covering of the Achilles tendon, is most often ruptured along with the tendon. This occurs usually as an acute process, with a sudden tear from excess ankle dorsiflexion at a greater force than the tendon can handle. Common mechanisms are from sports with quick changes in direction with running and jumping, such as basketball, tennis and soccer. Ruptures can also be chronic, which

occur most commonly after the 5th or 6th decade of life. Chronic Achilles tendon ruptures are typically a result of ongoing degeneration of the tendon with eventual full rupture due to tendon weakness and increased inflammation. Patients have an increased risk of chronic rupture if they have had a prior corticosteroid injection for treatment of Achilles tendinopathy. After healing from surgical repair or conservative treatment, the tendon will have scar tissue and irregular collagen deposition, disorganized compared to prior to tearing the tendon.

Symptoms [35]

Patients will report a sensation of being kicked with force to the calf with the possibility of a loud pop when the injury occurred. Patients will have pain in between the calf and heel along with bruising and swelling. They will likely be unable to plantar flex the foot when ambulating or standing. With an acute rupture the patient will likely report these symptoms that occurred suddenly while running, jumping or playing a sport

Assessment

1. Clinical
    a. For examination of the lower quarter, see Section 2. Clinicians should complete a full examination including everything from gait assessment to muscle length and strength and joint mobility.
    b. Acute Achilles tendon full ruptures will present differently than partial tears and tendinopathy. Patients may report they heard a “popping” noise while completing a running or jumping sport, followed by pain and inability to fully weight bear or plantar flex foot. There will likely be bruising in the lower leg to accompany these characteristics.
    c. Tests

        If two out of four or more of the following tests are positive, diagnosis can be confidently made of Achilles tendon rupture.

        i. Thompson test

            1. Examiner instructs the patient to lay prone with foot hanging off of the table. The examiner squeezes the calf muscle which should result in plantar flexion if the Achilles is

intact. If the Achilles is ruptured, the ankle will not plantar flex at all.

ii. Plantar flexion strength

1. Test resisted with patient in supine plantar flexing ankle into examiner's hand with the knee stabilized
2. Test with unilateral calf raises (normal strength at 5/5 is five heel raises through full range of motion)
3. Patient with full ruptured Achilles tendon will be unable to raise heel nearly at all

iii. Ability to palpate the ruptured tendon

1. The examiner should gently palpate along the calcaneus insertion superiorly along the tendon feeling for evidence of rupture or bound up tissue. If there is bound up tissue and ecchymosis present superior to the tendon, a clinician may suspect gastrocnemius strain/tear.

iv. Ability to increase dorsiflexion with mobility of the tendon

1. If a clinician can stabilize bound up tissue that is suspect for Achilles tendon rupture and dorsiflex the ankle further, the Achilles tendon is likely ruptured

2. Advanced Imaging

a. Imaging will support the clinically found diagnosis of Achilles tendon rupture. MRI or ultrasound are most commonly used.

b. Ultrasound is utilized as it can find a gap in tissue from a rupture and the examiner can move the ultrasound head in real time to examine the entire tendon.

c. MRI will reveal soft tissue differentiation, tendon swelling and thickness differences, and gaps in Achilles tendon via T1 and T2 increased signal intensity.

d. Radiographs of the ankle are used to diagnose or rule out fractures (especially calcaneus avulsion fracture which can occur with an Achilles

tendon rupture). They are also helpful in viewing swelling in the tendon and any differences in thickness of soft tissue.

Prognosis [1]

There is a good prognosis for patients who follow recommendations on return to activity after Achilles tendon rupture and repair. Overall, within three to five months patients will ambulate normally again. Patients who are instructed to weight bear early and complete rehabilitation outlined in the next section have a better prognosis. Patients generally will be able to return to running and light sports four to 5 months after injury, gradually and on an individual basis. As a measure of return of functional strength, patients should be able to complete full unilateral calf raises at 75% capability of the uninjured side. Around three quarters of patients will struggle to complete the unilateral calf raise at three months, but nearly all patients at six months have return of normal lower leg function and complete resolution of pain.

Surgical Repair or Conservative Immobilization [1,36]

A patient who has sustained an Achilles tendon rupture will face two options for management: surgical or conservative. Both options are followed by rehabilitation.

Surgical

1. Open posterior medial approach
    a. Most common due to higher healing potential with good vascularity on the medial aspect of the Achilles tendon
    b. Surgeon repairs the Achilles tendon, restoring normal length using the opposite leg's Achilles tendon length as a guide and then repairs the paratenon (tendon covering with high vascularity)
    c. Krackow suture method – surgeon uses loops that lock on both sides of the tendon to stabilize the tendon in place while it heals. This is the best suture technique in the literature for Achilles repair and has low likelihood the sutures would come out
    d. Sutures will hold the tendon in place for healing for 3 months
2. Percutaneous Repair, Mini-open procedure

a. Surgeon weaves sutures through aspects of the tendon guiding the tendon together

b. Mini-open procedure is safer to avoid nerve injury, which involves the same process as percutaneous procedure but is guided by a small opening which allows visualization with moving soft tissue out of the visual field.

c. The ankle ends up in a plantar flexed position after these procedures and is immobilized typically in a brace for the first week.

3. Risks of Surgery

    a. Infection

        i. Open repair has an infection rate of around 13%, which is a major reason that surgeons more commonly perform mini open repairs

    b. Systemic disease

        i. Patients who have poor circulation due to arterial disease that compromises healing or systemic diseases such as connective tissue disorders or Diabetes Mellitus may not heal appropriately from surgery. These patients may be more appropriate for conservative casting, especially if their goals are not to return to a sport or a physically demanding job

    c. Re-rupture

        i. Most common to occur within three months of surgery prior due to completing dorsiflexion prior to tendon healing

        ii. Around 4 percent of patients with surgical repair will re-rupture their tendon, and around 7% of patients with conservative casting will re-rupture their tendon

Conservative

1. Immobilization with hard cast in plantar flexion for one month then in neutral ankle position for 2 weeks to one month

2. Re-rupture rates are around 10% more likely than with surgical repair

3. Success rates are improved with early mobility with brace that allows movement from plantar flexion to neutral after three weeks of being completely immobilized

Rehabilitation Timeline and Protocol [1,36,37]

After Achilles tendon surgical repair

1. Immediately after surgery
    a. Early weight bearing is important in achieving the best outcome, but this is dependent on the surgeon's preference. It has been shown safe and effective to have patients fully weight bear when their ankle is plantar flexed around 30 degrees right after surgery
    b. Rehabilitation appointments typically begin within 2 weeks of surgery
    c. Patients may have weight bearing restrictions, such as toe touch weight bearing with crutches or a walker
2. 2 weeks to one month postoperative
    a. Early range of motion can begin as passive range of motion from full plantar flexion to neutral ankle position (no dorsiflexion). Clinicians should perform the range of motion slowly and gradually 3 sets of 15 to 20 repetitions
    b. Per surgeon's protocol, boot may be locked in plantar flexion for walking at this stage
    c. Weight bearing as tolerated status
3. 6 to 8 weeks postoperative
    a. Patients are progressing to not using braces at all, use of heel lifts may be helpful in reducing tensile force at the tendon depending on patient tolerance and surgeon preference.
    b. Gait training normalizing heel to toe sequencing, ankle range of motion in plantar and dorsiflexion, gentle calf stretching, balance exercises progressive from on floor to varying surface and bilateral to unilateral leg, progressive resistive strengthening in all ankle mobility

c. Lower extremity balance, strengthening, proprioception training based on gait, strength and balance assessment

4. Two months postoperative

    a. Continue normalizing gait without heel lifts, continue progressing active and passive dorsiflexion and plantar flexion range of motion toward normal levels. Use of stretching, soft tissue mobilization and joint mobilization may be used to achieve this

    b. Progressive eccentric protocol may begin with standing calf raises progressing toward bilateral and unilateral stance with heel off of a step at 2-3 sets of 10 repetitions.

    c. Lower extremity balance, strengthening, proprioception training based on gait, strength and balance assessment

After conservative management, immobilization [38]

1. Immediately after injury

    a. Ankle is immobilized via cast in some degree of plantar flexion (typically around 30 degrees)

    b. Weight bearing can begin immediately in cast/brace, but some orthopedists will have non weight bearing restrictions per protocol.

    c. Physical therapy focuses on pain control and maintenance of lower extremity mobility in the toes, knees and hip

2. Two to four weeks post injury

    a. If the surgeon's protocol was non weight bearing at first, will be able to weight bear at this stage within the patient's pain tolerance. Patient still wears an immobilizing walking boot dependent on orthopedist protocol

    b. Physical therapy will begin slow and passive ankle plantarflexion exercises and dorsiflexion only to boot position. Soft tissue mobilization is appropriate also

3. One to two months post injury

    a. Fully weight bearing with continued use, with walking boot positioned more towards neutral dorsiflexion (dependent on orthopedist’s protocol)

b. Physical therapy focuses on resistive plantar flexion, inversion and eversion exercises, typically with a resistance band at 3 sets of 10 to 15 repetitions. Seated calf raises and gait training reducing any compensations with gait pattern

4. Two to three months post injury

    a. If continuing to wear a walking boot per orthopedist protocol, patient can wean off of it by three months

    b. Physical therapy will continue to strengthen ankle plantar flexion, eversion and inversion and add dorsiflexion active range of motion to neutral ankle position. Seated calf raises will continue as well as balance exercise beginning with double limb support and progressing to single limb stance

5. Three to six months post injury

    a. This phase focuses on return to sport and patients should be wearing normal shoes and achieving normal dorsiflexion range of motion.

    b. Physical therapy continues to strengthen all ankle motions, achieve full active dorsiflexion range of motion with joint mobilization and soft tissue mobilization as aides, continue balance and ankle proprioception exercises on varying surfaces with eyes open and closed for challenge. It is appropriate to progress to eccentric loading programs suggested in the prior section with Achilles tendinopathy and advanced exercises such as alternating lunges and jump squats, depending on the patient's goals like return to sport.

    c. At six months post injury and casting/bracing, the patient should be fully recovered with return to sport.

With nonoperative and operative management for Achilles tendon rupture, some of the same intervention strategies can be used after one to two months to restore function in the lower extremity.

1. Joint mobility including low grade 1 and 2 progressing to grade 3-5 should be considered when progressing from neutral ankle dorsiflexion and gaining remainder of dorsiflexion mobility. This is typically around four to six weeks after initial injury or surgery.

2. Soft tissue mobilization, modalities such as iontophoresis, icing and heat application are strategies for pain relief that can be used within the first couple of weeks after surgery or when casting is able to be removed from nonoperative management.

Section 4 Summary

Achilles tendon rupture is defined as a complete tear of all the collagenous fibers of the Achilles tendon. This typically occurs as a sports injury with sudden change in movement such as running and jumping. This is managed conservatively with immobilization or surgically with repair to the tendon, both followed by progressive loading to the tendon depending on its strength from range of motion exercises to eccentric loading.

Section 4 Key Words

1. **Open posterior medial approach** – surgical repair option for Achilles tendon rupture where the surgeon repairs the Achilles tendon with looping and locking sutures, restoring the length normal
2. **Percutaneous Repair/mini-open procedure** – surgical repair for Achilles tendon rupture where the surgeon uses weaving sutures to reattach the ruptured ends of the tendon together

Section 5: Case Study

Case

John is a 45 year old male who comes to a direct access physical therapy clinic for evaluation with pain near his right heel. He reports the pain started after jumping for a rebound in a basketball league one week ago. He works as a carpenter and has had pain with walking, standing and reaching for objects when he is standing up on his toes. He describes the pain as dull and it dissipates when he is resting. He is limited in his ability to play basketball and work due to this injury. At examination, the patient is able to perform two full range of motion calf raises but it causes severe pain. The ankle does plantar flex in response to the Thompson test.

Reflection Questions

1. What additional information may be effective in gathering subjective history for management of this patient?
2. What is the general overview of tests and clinical examinations the clinician should perform?
3. What diagnosis should the clinician suspect based on the given information?
4. Outline the stages of rehabilitation including time frame and general intervention.
5. How would intervention differ with full rupture compared to a partial tear of the Achilles tendon?

Responses

1. Some additional information to inquire about could be what besides rest may alleviate the pain (icing, heat, NSAIDs), if they have seen another healthcare provider and recommendations from that person, whether they had any pain in the heel or calf prior to this injury. A clinician would also want to have the patient fill out an outcome measure such as the LEFS, VISA-A or FAAM to objectively document and follow up with pain and disability the injury has caused.
2. The clinician will examine lower extremity strength, range of motion, posture, joint mobility and special tests to rule in or out specific pathology. For this patient, a clinician will need to determine whether the Achilles tendon is involved and whether the patient has a partial tear or full rupture. This can be determined by the four tests to rule in Achilles tendon rupture including Thompson test, ability to palpate the ruptured tendon, plantar flexion strength and the ability to increase dorsiflexion with mobility of the tendon. The clinician will also need to rule in/out other pathologies such as gastrocnemius strain, calcaneal avulsion fracture and ankle sprain and refer for imaging in the case of suspected fracture.
3. The clinician should consider Achilles partial tear, Achilles tendon rupture and gastrocnemius strain based on the above information. Due to the patient's ability to complete at least one full calf raise and Thompson test being negative, this patient most likely has midportion Achilles partial tear.

4. For the first six weeks, the clinician should instruct patients to avoid stretching the calf but that walking is not harmful. For seven weeks to three months the patient should perform calf raises progressing from sitting to standing to unilateral with minimal pain levels. After three months or when the patient is pain free they are able to progress to eccentric protocol including calf raises from bilateral to unilateral with heel off of a step to strengthen tendon loading response. Patients at this stage can progress gradually back to normal activity level but only when pain free to avoid recurrence. Heel lifts from 2 then to 1 cm may be used for pain relief for up to three months.

5. Full rupture should be referred to an orthopedic specialist for surgical versus nonoperative management. Depending on selection by the surgeon and patient, after surgery patients should be immobilized for around three weeks with early weight bearing and progressing range of motion and strengthening from sitting exercises to standing and unilateral eccentric calf raises. For conservative management, patients will be immobilized for around three weeks in plantar flexion, then allow movement to neutral. At that point patients will progress in rehabilitation from neutral range of motion gradually to full plantar flexion with eccentric loading. With conservative or operative management, progression is based on tendon healing, pain response and individual characteristics of the patient such as comorbidities and activity level.

Conclusion

Achilles tendon injury is fairly common, especially in middle aged intermittently active males. Tendon injury ranges from Achilles tendinopathy to tendon partial tear to full thickness rupture. Recovery time varies, from Achilles tendinopathy often taking up to six months, Achilles tendon partial tear taking around three months and Achilles tendon rupture taking around six months for complete symptom resolution. Generally, rehabilitation focuses on symptoms, stages and timelines for loading the Achilles tendon when safe to do so. Exercises should progress from gentle range of motion (if operative this is after cleared per surgeon's protocol, typically around three weeks) to strengthening. Clinicians should direct patients to begin strengthening gradually, progressing from seated calf raises to standing calf raises and eventually eccentric tendon loading protocol when pain free to restore normal functioning of the Achilles tendon and gastrocnemius complex. Clinicians should always be mindful of individuality in patients with respect to healing. This is especially true if a patient has a connective tissue disorder, is on medication that weakens connective tissue (corticosteroid injection

around Achilles tendon for example) or they had a degenerative rupture as healing time may increase which may slow down progression of exercise. A patient should be offered an exercise protocol and joint mobilization, soft tissue mobilization and other modalities that ease recovery and assist with progression back to prior level of function as part of a comprehensive rehabilitation program.

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