Disclosure Statement

• American Academy of Orthopaedic Surgeons (AAOS)
  – Committee member

• American Orthopaedic Foot & Ankle Society (AOFAS)
  – Committee member
Anatomy of the Achilles Tendon

- Strongest, largest tendon
- Originates from distal gastrocnemius-soleus muscle
- Inserts at postero-superior calcaneal tuberosity – 2 cm x 2 cm

Function

- **Plantarflexion**
  - Gastrocnemius flexes the ankle with the knee extended
  - Soleus flexes the ankle with the knee flexed

- **Eccentric lengthening**

- **Concentric contracture**

Blood Supply

• Distally from calcaneus

• Proximally from gastrocnemius-soleus muscle

• Peritenon

• At 2-6 cm from insertion
  – Twists 90° on itself
  – Watershed zone of decreased vascularity
  – Most common site of rupture (75%)

Matusz P. Clin Anat 2010; 23: 243-244.
Tendinopathy

Rupture
Achilles Tendinopathy

Peritendinitis

Tendinitis

Tendinosis
Staging

• Stage 1 = Peritendinitis
  – Inflamed peritenon & bursae
  – Tendon is normal
  – Reversible

• Stage 2 = Tendinitis
  – With tendon inflammation & thickening
  – Reversible

• Stage 3 = Tendinosis
  – Mucoid degeneration ± calcific changes
  – No inflammatory response & irreversible

Classification

- **Duration**
  - Acute = Less than 2 weeks
  - Subacute = 2-6 weeks
  - Chronic = 6 weeks +

- **Location**
  - Insertional
  - Midsubstance
Epidemiology

• Extrinsic factors
  – Surface conditions
  – Shoe wear
  – Over-activity
    » Work vs. exercise

• Intrinsic factors
  – Age
  – Medical conditions
    » Obesity & hypertension
  – Medications
    » Steroids

History & Physical

• Symptoms
  – Activity-related pain

• Exam
  – Location of tenderness
  – Swelling or protuberance
    » Haglund’s deformity at the postero superior calcaneus?
  – Strength
  – Thompson test

Radiographs

• 1st line of imaging

• Weightbearing anteroposterior (AP) & lateral of ankle

• Screen for –
  – Calcification within the tendon
  – Haglund’s deformity

• Measure –
  – Phillip-Fowler’s angle

Further Imaging

- **MRI**
  - Gold standard for tendon visualization
  - Important for surgical planning

- **US**
  - Increased use recently
    » Less expensive?
  - Increased role in surgical revision situations

Foure A. Front Physiol 2016; 7: 324.
Nonoperative Treatment

• 1\textsuperscript{st} stage
  – Rest
  – Immobilization
    » Cast vs. Achilles boot
  – Non-steroidal anti-inflammatory (NSAIDs)

• 2\textsuperscript{nd} stage
  – Eccentric stretching
  – Physical therapy (PT)
  – Heel lifts as needed

• Most successful in early stages

Other Nonoperative Treatments?

• Steroid injections?
  – Risk of Achilles rupture!

• Platelet rich plasma (PRP) injections?
  – Many studies show no difference compared to placebo

• Extracorporeal shock wave therapy (ESWT)?
  – 30-90% successful

Surgical Treatment of Insertional Tendinopathy

• Debridement & repair
  – Repair the Achilles also back to the calcaneal insertion

• Haglund’s exostectomy as needed

• Posterior midline incision splitting the Achilles

Surgical Treatment of Midsubstance Tendinopathy

• Debridement & repair

• Posteromedial incision
  – Adjacent to the tendon’s medial border
  – Splitting the Achilles

When to Augment the Repair?

• **Absolute indications**
  – > 50% of tendon width resected

• **Relative indications**
  – Based on age, weight, & activity level

• **Flexor hallucis longus (FHL)**
  – Located anterior to the Achilles
  – Large muscle belly
  – In phase with the Achilles tendon

[Long] Harvest of the FHL

- Traditional
  - 2\textsuperscript{nd} incision at the plantar-medial foot
  - Harvested at the knot of Henry
  - Tenodesis of distal FHL to the flexor digitorum longus (FDL)

[Short] Harvest of the FHL

• More recent alternative
  – Through the Achilles incision
    » No additional incisions needed
  – Harvested at the posteromedial hindfoot
    » Less length of tendon harvested without tenodesis of the distal FHL to the FDL

Fixation of the FHL

- Direct tenodesis to the Achilles

- Weaved through bone tunnels in the calcaneus

- Interference screw fit through a bone tunnel in the calcaneus
  - My preference
Postoperative Care

- **Weeks 0-2**
  - Non-weightbearing in splint
- **Weeks 2-6**
  - Non-weightbearing in Achilles boot
- **Weeks 6-12**
  - Weightbearing in boot
  - PT
- **Week 12-onwards**
  - Discontinue boot
  - Return to activity with a home exercise program (HEP)
  - PT?
Results

• 85+% success
  – Improvement of pain
  – Return to function

• Education
  – Home stretching
  – Avoid overuse

Complications

- Infection
- Wound problems
- Nerve injury
  - Sural nerve
- Achilles rupture
- Recurrent tendinitis
  - Inadequate exostectomy or tendon debridement?
Achilles Rupture

- Most common tendon rupture in lower extremity

- Viscoelastic with rapid loading
  - Stiffness occurs with increased Young's modulus
  - Prone to rupture

Hunt K et al. Foot Ankle Spec 2014; 7: 199-207.
Epidemiology

• Activities involved
  – Athletics

• Age
  – Peak incidence in 3\textsuperscript{rd} – 5\textsuperscript{th} decades
  – Physical conditioning
  – “Weekend warriors”

• Sex
  – Male: female is 5: 1

• Side
  – Left > Right

Classification

Myotendinous
4-14%

Midsubstance
75%

Insertional
14-24%
Classification cont.

- Acute = 0-2 weeks
- Subacute = 2-6 weeks
- Chronic = 6+ weeks

Make note of those that are neglected or missed!

Etiology - Indirect Trauma

- Strong ankle dorsiflexion force with contraction of the gastrocnemius-soleus
- Strong ankle dorsiflexion force while plantarflexed
- Push off of the foot with the knee extended

Etiology - Direct Trauma

- Direct blow
- Crush
- Laceration

Predisposing Factors

• Inflammatory arthritides

• Endocrine dysfunction

• Pharmacologic
  – Corticosteroids
    » Oral vs. intravenous
  – Fluoroquinolones

• Achilles tendinopathy
  – Supported by intra-operative histology

History

• Activity involved
• Predisposing factors
• Initial pain
  – “Pop” or “Explosion”
  – Often subsides
• Difficulty weightbearing
• Difficulty walking
  – Weakened plantarflexion
  – Stair climbing

Physical Examination

- Decreased strength
- Palpable gap at tendon
- Ecchymoses
- Swelling — Can obscure the gap!
- Abnormal Thompson test
Radiographs

• 1st line of imaging

• AP & lateral of ankle
  – Blurring of Kager’s triangle

• Screen for –
  – Calcaneal fracture
  – Sleeve vs. posterior tuberosity

Further Imaging

- **MRI**
  - Gold standard for tendon visualization
  - Useful for –
    - Determining location of rupture
    - Measuring the gap between tendon ends in subacute/chronic ruptures

- **US**
  - Increased use recently
  - Increased role is surgical revision situations?

Myotendinous Achilles Ruptures

- Should be confirmed with MRI vs. US

- Nonsurgical treatment
  - Minimal displacement occurs
  - Highly vascular at the myotendinous junction

- Protocol
  - Nonweightbearing in Achilles boot x 2-4 weeks
  - Weightbearing in Achilles boot x 4 weeks
    » With HEP vs. PT
  - Wean out of boot by 6-8 weeks
    » Further PT?
  - Return to activity

- Good functional results
Mid-Substance Achilles Ruptures

• Nonsurgical treatment

• Strong indications in patients with –
  – Significant illness with medical co-morbidities
    » Peripheral vascular disease (PVD)
    » Poorly controlled diabetes mellitus (DM)
    » Physically debilitated
    » Highly advanced age
  – Poor skin condition
  – High risk for post-surgical complications

• Relative indications
  – As an alternative to surgery in a reliable patient population

Nonoperative Treatment with Functional Rehabilitation

- Short leg cast with the ankle in resting equinus x 2-4 weeks
  - Nonweightbearing

- CAM boot immobilization x 4 weeks
  - Progressive weightbearing
  - Heel wedges in the boot with gradual removal
  - Gentle motion & stretching

- Removable brace x 4-8 weeks
  - PT
Expectations of Nonsurgical Treatment

- Most comparative studies show –
  - Higher risk of Achilles re-rupture
  - Decreased gastrocnemius strength
Insertional Achilles Ruptures

• Nonsurgical treatment?
  – Lacking in outcome studies
  – May be considered in patients with –
    » Significant illness with medical co-morbidities
      – PVD & brittle DM
      – Physically debilitated ± highly advanced age
    » Poor skin condition
    » High risk for post-surgical complications
  – Expect poor healing potential between calcaneal periosteum & insertional Achilles

• Surgical treatment
  – Traditional for healthy, active patients

Surgical Treatment of the Acute Rupture

• Traditional = primary open repair

• Incision
  – Posterior
  – Medial to the tendon mid-substance
  – Midline at the insertion

• Technique
  – Krackow vs. Bunnell
  – Epitendinous repair
  – Suture anchors if insertional
Percutaneous Repair of the Acute Rupture

• Alternative to an open repair

• Advantages
  – Smaller wound with decreased wound complications

• Disadvantages
  – Mixed results compared to open repair
  – Learning curve
  – Sural nerve injury
Augmenting the Acute Repair?

• Plantaris tendon augmentation?
  – Relative indications if intact

• FHL augmentation?
  – Indicated only if repair is unstable

• PRP?
  – Mixed results
  – Further study required
Postoperative Treatment of Tendon Repair

• Weeks 0-2
  – Nonweightbearing in splint

• Weeks 2-4
  – Non- vs. partial weightbearing in Achilles boot
  – Progression to neutral alignment

• Weeks 4-8
  – Progressive weightbearing in Achilles boot
  – HEP vs. PT

• Weeks 8-12
  – Wean from boot
  – PT
Postoperative Treatment After 12 Weeks

• Week 12
  – Continue therapy to optimize strength

• After Week 16
  – Begin return to sports
Results

• 92+% success overall
  – Improvement of pain
  – Return to function

• For professional athletes
  – 1/3 never return to professional play
  – 1/2 of those that do return play at decreased strength
Complications

• Infection

• Wound problems
  – Superficial vs. deep

• Sural nerve injury

• Achilles re-rupture
  – < 2%

• Deep vein thrombosis

Subacute & Chronic Ruptures

• Most commonly occurs due to delay in diagnosis

• Sequelae
  – Tendon proximal to the rupture retracts
  – Gap develops at the rupture site
  – Inefficient scar fills the gap
  – Decreased strength
  – Fatigue
  – Inefficient gait

Nonsurgical Treatment - Accommodative

• High-topped shoes

• Lace-up braces

• Ankle foot orthosis (AFO)
  – Molded AFO (MAFO)
  – Dorsiflexion-assist

Surgical Reconstruction

• To restore strength

• To restore Achilles continuity
  – Involves excision of scar
  – Bridging the gap

• Technique depends on length of the gap
When the Gap is < 2 cm

- End-to-end repair with longitudinal traction applied to the tendon edges

- Creep

When the Gap is 2-6 cm

- V-Y gastrocnemius lengthening

When the Gap is 6-12 cm

- Achilles turndown
  - Historical techniques
    » Bosworth
    » Arner & Lindholm
  - Modern techniques
    » Ahmad et al.

Ahmad J et al. Foot Ankle Spec 2016; 9: 400-408.
When the Gap is > 12 cm

• FHL tendon transfer into the posterior calcaneus?
  – WITHOUT bridging the gap at the ruptured Achilles

• Tendon allograft?
  – Achilles vs. hamstrings

• Requires further study
  – Limited to scant case studies

When to Use the FHL?

• To augment the reconstruction
  – Regardless of gap size

• As a sole tendon transfer
  – WITHOUT bridging the gap

Postoperative Treatment

- **Weeks 0-2**
  - Nonweightbearing in splint
- **Weeks 2-6**
  - Nonweightbearing in Achilles boot vs. cast
- **Weeks 6-12**
  - Progression to full weightbearing in boot
  - Physical therapy
- **Week 12**
  - Discontinue Achilles boot
  - Continue therapy to optimize strength
Results

• 85+% success overall
  – Improvement of pain
  – Improvement of strength

• Better chances of return to pre-injury levels of activity with tendon reconstruction & FHL augmentation?
  – Comparative studies are lacking
Complications

- Infection
  - Higher than for acute repair
- Wound problems
  - Longer incisions
  - Higher than for acute repair
- Sural nerve injury
- Achilles re-rupture
  - < 2%
- Deep vein thrombosis
- Foreign body reactions

Ahmad J et al. Submitted for publication in Foot Ankle Int in 2018.
Conclusion

• The Achilles tendon is critical to efficient gait
  – Ankle function
  – Stair climbing

• Its blood supply makes it vulnerable to pathology
  – Watershed area at the mid-substance
Achilles Tendinopathy

• Nonsurgical treatments are beneficial in early stages

• Surgical treatment involves debridement & repair
  – With a Haglund’s exostectomy when there is insertional Achilles involvement
  – + FHL augmentation with significant de-bulking of the Achilles
Achilles Tendon Ruptures

• Nonsurgical treatment
  – Myotendinous ruptures
  – Mid-substance ruptures
    » In patients not suitable for surgery
    » As an alternative in healthy patients to avoid complications
Achilles Tendon Ruptures cont.

- Surgical treatment
  - Acute repair
    - Insertional ruptures
    - Mid-substance ruptures
      - To avoid muscle atrophy & re-rupture
  - Reconstruction ± FHL transfer
    - Technique depends on the amount of gapping between the ends of the ruptured Achilles
Questions?
Thank you.