Ankle Fractures Epidemiology

- Occur in 187 per 100,000 persons annually 4
- Mean age of ankle fracture is 49 yo. with peaks in younger males and older females
- Unimalleolar fractures represent 70% of all fractures
  – Bimalleolar fractures 20% (medial and lateral malleolus)
  – Trimalleolar fractures 10% (medial, lateral and posterior malleolus)
- Mechanism of injury
  – 61% fall from standing height
  – 22% from sports 3
- 53% ankle fractures are unstable requiring surgery 7
Pediatric Epidemiology

- Ankle fracture most common physeal injury of LE
- Fractures with adolescents more likely to need surgery than any other fracture
- Higher incidence of fracture with kids with increased BMI
- Basketball, soccer, football and scooters are most common activities associated with fracture

Ankle Anatomy

**Distal tibiofibular syndesmosis**
- Complex of ligaments providing dynamic stability at lateral ankle
  - Anterior inferior tibiofibular ligament
  - Posterior inferior tibiofibular ligament
  - Inferior transverse tibiofibular ligament
  - Interosseous ligament

**Deltoid Ligament**: stabilizes ankle on medial side
Growth Plates

• The physis contains 4 zones from epiphysis to metaphysis
  — Reserve, proliferative, hypertrophic and provisional calcification zone
  — Reserve zone contains progenitor cells for physisal growth
  — Fractures that cross physis into epiphysis (Salter Harris types III & IV) may damage reserve zone thus higher risk of growth arrest (LLD)

• Distal tibia and fibula physis closure occurs
  — Boys 15-20 yrs; Girls 12-17 yrs

• Ligamentous structures in children are robust; physis is biomechanical vulnerable to shear and rotational forces

• Of all physisal injuries, fx of distal tibia physis have among highest rate of complications
  — Premature physisal arrest, bar formation, angular deformity and articular incongruity

1 Presentation Title  l February 26, 2018  l 5
Salter Harris Classification
S (separated) Type I
A (above) Type II
L (lower) Type III
T (thru and thru) Type IV
R (rammed/crushed) Type V (rare)

Lauge-Hansen Classification 4 Types

• Based on position of foot when injured and force
  1. Supination-Adduction (injury starts on lateral side)
  2. Supination- External rotation (SER)
  3. Pronation- Abduction (injury starts on medial side)
  4. Pronation- External rotation (PER)

• Supination-External Rotation- most common
  – Foot in supination during injury and force is external rotation
    – Stage 1: anterior tibiofibular ligament
    – Stage 2: fibula fracture
    – Stage 3: posterior tibiofibular ligament
    – Stage 4: medial malleolus or deltoid ligament
Danis-Weber Classification

Based on level of fibula fracture

- Weber A: fx below level of distal tibiofibular joint (ie. syndesmosis)
  - Rarely unstable
- Weber B: fx at the level of syndesmosis
  - Possibly unstable
- Weber C: fx above the level of syndesmosis
  - Usually unstable

Unstable = ORIF
Determinate of ankle stability

1) Medial Clear Space
   • <4-5 mm is normal
   • >5 mm causes instability

2) Syndesmosis
   • <5 mm is normal
   • >5 mm causes instability

Widened medial ankle joint space

- Indicates a taler shift and deltoid ligament injury
  - seen on stress XR views
- Injury to deltoid ligament will most likely need surgery
- Level of injury determines treatment plan

Example:
- Supination-external rotation injury
  - Stage 2 -> boot and WBAT
  - Stage 4 -> surgery
Syndesmotic Injury

• Separation of syndesmosis disrupts integrity of ankle
  • Occurs in 11-20% of malleolar fx

• Syndesmotic injury mostly caused by pronation-external rotation and less frequently by supination-external rotation injury

• Syndesmosis separation >5mm leads to instability

• Talus moves 1mm laterally causes 42% decrease at tibiotaler articulation

• Early reconstruction of unstable syndesmosis indicated to avoid degenerative arthritis

Treatment Strategies Depend on Fx Type and Stability

• Long term treatment goal
  1. Minimize angular deformity
  2. Minimize leg length discrepancy (pediatrics)
  3. Avoid posttraumatic arthritis
  4. ACHIEVE NORMAL ANKLE FUNCTION

• Non displaced fractures -> cast; WB status and duration of immobilization depends on fracture type and stability

• Low risk ankle fractures -> air splint or walking boot
  – Includes distal fibular fractures, nondisplaced fibular SH-I fractures and lateral talus avulsion fractures

Presentation Title | February 26, 2018 | 13
Treatment Strategies Must Preserve Ankle Mortise

• Simple displaced tibia and fibula fractures -> closed reduction and casting
  – May be successful for SH I and SH II patterns

• Unstable fracture patterns unable to achieve satisfactory closed reduction -> open reduction

• ORIF (open reduction and internal fixation)
  – Recommended for displaced intra-articular fractures
  – Surgical fixation associated with lower rate of physeal arrest with SH III and IV compared to CR alone
  – Partially threaded cannulated screws or smooth pins, or plate-screw construct
  – Often patients have closed reduction and splinting then return for surgery after swelling resolves to minimize wound complications; wait till the skin wrinkles
Unimalleolar Fracture

Bimalleolar ankle fracture
Trimalleolar Fracture

- Fracture
  1) Medial malleolus
  2) Lateral malleolus
  3) Posterior malleolus
- ORIF needed for larger fracture size of posterior malleolus
  - >25% distal articular surface

Posterior malleolar fracture
Salter Harris Type III Fracture ORIF

Fibular Weber C fracture with syndesmotic fixation
Indications for screw fixation:

- No need for syndesmotic screw in low fibular fractures (<5cm above ankle joint)
  1. Medial and lateral malleoli are anatomically reduced
  2. Deltoid ligament remains intact
- Screw needed with high fibula fractures (>5cm above ankle joint) in order to maintain stability of ankle mortise.

Screw Removal = controversial??

- Recent reports say to delay to 12 weeks
- WB may increase risk of screw breakage
- Anterior tibiofibular distance widened after 1 year of screw removal -&gt; arthritis??

Post operative management
Syndesmotic ORIF


- Controversy in literature on when to start weight bearing
  - Early studies said weight bear only after screw removal
  - This review suggested WB in plaster cast post-op
- Screw removal?
  - Most recent studies found no impaired functional capacity in ankles with retained screws
  - Low complications with syndesmotic ORIF and far greater disability with chronic ankle instability (screws can break but this is rare)
  - Concluded screw removal only in symptomatic ankles
Post operative management
Syndesmotic ORIF

Boyle et al. Removal of the syndesmotic screw after the surgical treatment of a fracture of the ankle in adult patients does not affect one-year outcomes. (2014)

RCT: 51 patients; 2 groups: retention or removal of screw

• Concluded that removal of syndesmotic screw produces no significant functional, clinical or radiological benefit in adults.

• 76% patients in retention group had loose and/or broken screws at 1 year

Post operative Management
Ankle ORIF

Smeeing et al. Weight bearing and mobilization in postoperative care of ankle fractures: a systematic review and meta-analysis of RCTs and cohort studies (2015)

25 articles

• Active exercises accelerate return to work and daily activities compared to immobilization

• Early weight bearing tends to accelerate return to work and daily activities

• Supports early weight bearing and active exercise post op ORIF
Post operative management
Ankle ORIF

Keene et al. Early ankle movement versus immobilization in the postoperative management of ankle fractures in adults: a systematic review and meta-analysis (2014)

14 studies: poor quality of studies
• Effects of early movement versus immobilization = unclear
• Small reduction in risk of thromboembolism with early mvt
• Deep and superficial surgery site infections, fixation failure and need to remove hardware are more common after early movement

Dehghan et al. Early weight bearing and range of motion versus non-weight bearing and immobilization after ORIF of unstable ankle fractures: A RCT (2016)

110 ORIF patients; 2 groups
– Early (WB and ROM at 2 weeks)
– Late (NWB and cast immobilization for 6 weeks)

• Results:
  – No difference in RTW
  – At 6 weeks: early group had more ROM
  – No difference in wound complications, infections, and no fixation failure
  – Late group had higher rate of planned hardware removal due to plate irritation
Post operative management
Ankle ORIF

Research on Rehabilitation

- Step length, stride length, velocity and single support phase all improved after 12 week rehabilitation program \(^{10}\)

- Gait deviations can still be seen 1 year post-op
  - Focus on step length and stride time (esp. >50 years old) \(^{10}\)

- 12 week exercise program decreases stiffness & swelling
  - 1/3 of patients has difficulty with running, jumping, and squatting \(^{10}\)

Manual Techniques

- Soft tissue mobilization with elevation
- Subtaler joint mobilizations to promote calcaneal inversion and eversion
- Forefoot ab/adduction mobilization to promote supination and pronation
- Dorsiflexion mobilization
- Don’t forget about the toes
  - Work on great toe extension to promote windless effect and re-supination of the foot during terminal stance
Exercises

- ROM exercises
- Strengthen
  - Intrinsic muscles
  - Extrinsic muscles
  - Hip muscles
  - Core muscles
  - Knee muscles
- Balance training
  - Static
  - Dynamic
- Proprioceptive training
- Gait training
- Plyometric training

Outcomes

Functional Outcomes and Quality of Life After Ankle Fracture Surgically Treated: Systematic Review
Rde et al. J of Sport Rehabilitation, 2017

Results: SF-36 tool
- Functional and physical limitations even 2 years after injury
  - More common in younger adults vs elderly
- Most report no pain over time
- General health status similar to controls
- Vitality and energy levels similar to controls in elderly and adults with 1-2 yr. follow-up.

Conclusion:
- Long-term functional rehabilitation programs are essential for recovery and preservation of QOL after ORIF
  7
Outcomes after ankle fracture fixation

• Adults have rapid initial recovery (SR) \(^{11}\)
  – 80% return of physical function in first 6 months
  – recovery remains incomplete at 24 months
  – More severe fractures = greater activity limitation

• 72 military men with ankle ORIF \(^{10}\)
  – 64% return to running in 2 years

• 47 patients with bimalleolar and trimalleolar ORIF \(^{12}\)
  – 1 year showed good function and good to excellent O&M scores
  – 55.3% residual pain; 61.7% stiffness; 44.7% swelling
  – 27.3% returned to pre-injury sport level; 18.2% no sports at all
  – No difference b/t bimalleolar and trimalleolar fractures

Outcomes after ankle fracture fixation

• Trimalleolar fractures: poorer functional outcomes as posterior malleolus fragment size increases
  – 25% less likely to return to sporting activities \(^{8}\)

• 281 patients ankle ORIF at 11.6 years post surgery \(^{16}\)
  – Short Musculoskeletal Function Assessment (SFMA)
  – Most patients are doing well
  – 63% have radiographic arthritis but deny significant limitation or pain
  – Encouraging as functional outcomes are maintained over time
Factors affecting outcome after ankle ORIF

• Age
  – Patients >45 yo. 3 times less likely to return to their work than younger patients 7
  – Recovery faster <40 yo. in first 6 months; 1 year- no difference with age 10

• Severity of Trauma (high energy vs low energy)

• Smokers – negative effects on osseous unions (SR) 13

• Higher BMI: more complications and worse functional outcomes 3-6 years after ankle surgery 14

• Catastrophizing behavior patterns and depressive symptoms
  – More severe pain and worse function after traumatic injury
  – Pain Catastrophizing Scale (PCS)
  – Use our Pain Neuroscience Education tool kit or recommend psych 15

Summary

• Beneficial for surgeons to use removable immobilization device to allow for early ankle range of motion and exercise

• PTs should understand the type of ankle fracture/injury

• Educate patient on realistic outcome expectations and commitment to rehabilitation for improved quality of life

• Utilize manual techniques to improve swelling and mobility to promote supination and pronation

• Space out physical therapy visits to allow time for optimal progression with home exercise program
References

9) Boyle et al. Removal of the syndesmotic screw after the surgical treatment of a fracture of the ankle in adult patients does not affect one year outcomes: RCT. 2014; 96B(12): 1699-1705.
Thank You!

877-440-TEAM
sports-health.org
Anatomy of lateral ankle

- Peroneus longus tendon
  - Everts, abducts and plantarflexes
Anatomy of lateral ankle

- Peroneus brevis tendon
  - Everts, abducts and plantarflexes

- Superior peroneal retinaculum
- Distal fibula
Normal Foot/Ankle Biomechanics

• Supination
  • Combination of:
    • Plantarflexion
    • Forefoot adduction
    • Inversion of rearfoot
  • Functional significance
    • Creates rigid lever during push off
    • Relative medial insertion of achilles tendon facilitates inversion of rearfoot

Normal Foot/Ankle Biomechanics

• Pronation
  • Combination of:
    • Dorsiflexion
    • Forefoot abduction
    • Eversion
  • Functional significance
    • Shock absorption at heel strike by unlocking tarsal joint
    • Affords approximately 50% force dissipation
Foot/Ankle Biomechanics

More than just simply arch height

- The dynamic function of foot/ankle complex in weightbearing helps determine whether function is normal or abnormal (symptomatic)
Abnormal Foot/Ankle Biomechanics

Over-pronation – Pes planus

- Incidence:
  - 13.6% (500 healthy 18-21 year olds)\(^1\)
  - 15.5% (512 newly admitted West Point cadets)\(^6\)
- Implications:
  - Lack of rigidity can lead to:
    - Plantar fasciitis
    - Achilles tendonitis
    - Hallux valgus/bunion formation
    - Medial ankle/knee pain

Abnormal Foot/Ankle Biomechanics

Under-pronation – Pes Cavus

- Incidence:
  - 10% (according to Japas in J Bone Joint Surgery)\(^4\)
  - 8-15% (according to various online sources)
  - 25% of population under-pronates(subtle cavus foot) according to Chilvers et al even if pes cavus definition not met\(^2\)
- Implications:
  - 2001 survey of 40 runners by Williams et al\(^8\)
    - 20 had high arches, 20 low arches
    - High arch runners had higher rate of foot/ankle injuries
    - Low arch runners had higher rate of knee injuries
Abnormal Foot/Ankle Biomechanics

• Pes Cavus
  • Implications of rigid foot:
    • Lack of flexibility leads to:
      • Decreased force dissipation/stress fractures
        • 449 Navy Seal candidates followed over 2 years had high rate of stress fractures when high arch present.\(^5\)
      • Increased stress on lateral ankle stabilization structures
        • Chronic inversion ankle sprains
        • Chronic peroneal tendonitis
        • Chronic lateral ankle pain
        • Eventual failure of lateral soft tissues

Pronation and Supination

Supination
- Ankle leans outward
- High arch

Neutral
- Ankle do not lean
- Normal arch

Pronation
- Ankle leans inward
- Low arch (flat foot)
Case Study

• 53 year old male
• Maintenance job in factory requires:
  • Lots of walking on level and unlevel surfaces (mostly concrete)
  • Lots of climbing ladders and on and off large equipment
• Chronic lateral right ankle pain
  • Surgical history includes R lateral ankle reconstruction 2012
• Injured lateral R ankle at work on 2/13/2016
• Conservative treatment failed

Case Study

• MRI revealed:
  • 10 cm longitudinal tear of peroneus longus tendon
  • 4 cm longitudinal tear of peroneus brevis tendon
  • Evidence of dislocation of both tendons
• Surgery 8/17/2016:
  • Repair of right peroneus longus and brevis tendons
  • Right distal fibular osteotomy smoothed with bone wax
  • Repair of right superior peroneal retinaculum
Case Study

- Post-op Course:
  - NWB on R LE 2.5 wks with cast and crutches
  - Post-op boot with crutches and self progression to FWBing as tolerated until 6 weeks post-op.

- PT evaluation 9/28/2016 (6 wks post-op)
  - Arrived with boot and no crutches FWB
  - Wearing shoe and soft brace at home on level surfaces indoors
  - Pain – constant and varied from 3-6/10
  - ROM – deficits as expected following immobilization
  - Strength – deficits as expected following immobilization
  - Gait – deviations as expected (asymmetrical step lengths, etc)
Case Study

PT Treatment

- Early phase: typical
  - Gait training
  - Seated AROM
  - Seated stretching
  - Seated BAPs
  - Low load strengthening
  - Proprioceptive exercise
- Progressed to WBing therex as tolerated

Case Study

Obvious right pes cavus led to concerns about re-injury

- More detailed exam 10/26/2016 revealed:
  - 6 degree right rearfoot varus in subtalar neutral prone
  - 7 degree right forefoot varus in subtalar neutral prone
  - 4 mm navicular drop on right (normal=6-8 mm)

- Conclusion:
  - Rigid right pes cavus foot (uncompensated varus)
  - **Significant** risk for re-injury secondary abnormal biomechanics (under-pronation)
  - Mechanism of injury unchanged – pes cavus
Key Clinical Sign of Pes Cavus

“Peek-a-boo” heel:
• Medial prominence of heel pad visible from front

Case Study

Treatment adjustments based on pes cavus:
• Standing gastroc/soleus stretch at wall:
  • Modified to allow toe out and encourage pronation
  • Modified with lateral wedge (4-8 degree) to encourage pronation
Case Study

Treatment adjustments based on pes cavus:

• Self mobilizations of rearfoot and forefoot with cross towel technique
• Single leg stance ball toss to rebounder
• Lateral step ups on and over dome side of BOSU
• Forward and lateral lunges onto dome side of BOSU
• WBing right single leg stance t-band 4 way hip strengthening
  • Without lateral wedge under foot
  • With lateral wedge under foot

Results:

• 30 PT visits from 9/28/2016 to 2/1/2017
• Returned to work on 12/8/2016 without restrictions
• Gait and stairs normal
• After modifications to address pes cavus mechanics 10/26/2016
  • Pain decreased to 0/10 at end of each session
  • Pronation (eversion/forefoot abduction)
    • Increased from 9 degrees to 29 degrees
Case Study

One year follow up:
- Still compliant with HEP stretches
- Increased awareness of foot/ankle biomechanics even today
- Forced to change jobs with new job more physically demanding
  - Increased climbing
  - Increased heavy lifting
  - 100% labor vs. 50/50 labor/desk
- No restrictions or limitations at work
- No restrictions with ADLs or recreation
- Intermittent pain/soreness at night or at rest after activity
  - HEP stretches relieve pain

Discussion:
- Repeat injury from 2012 likely the result of pes cavus not addressed.
- Same surgeon and surgery 2012 and 2016
- Second surgery tighter than first
- PT following second surgery:
  - Similar amount to first surgery
  - Increased focus on pes cavus biomechanics
Questions?

Bibliography


Thank You!
Achilles Tendon Rupture

• **Mechanism of injury-**
  
  • Acute injury-Sudden forced plantar flexion, sudden forced dorsiflexion from the plantar flexed position, unexpected dorsiflexion of the foot

  • Chronic injury-calcaneal osteophytes gradually wearing down the tendon, chronic tendonosis
Achilles Tendon Rupture

• Initial treatment
  – Ice
  – Elevation
  – Crutches and Immobilization
  – X-rays and MRI

Achilles Tendon Rupture

• Treated operative or non-operative
• Operative
  – Usually younger patients with good tendon quality and healthy
  – Athletes who would like to return to regular athletic activity
  – Demanding occupations
• Non-Operative
  – Older patients
  – Patients with other co-morbidities that may affect outcomes
  – Patient choice
Achilles Tendon Rupture-Operate or Not? What does the literature say?

• Mark-Christensen et al Knee Surg Sports Traumatol Arthrosc 2016
  – Systematic review of current evidence for both operative and non-operative treatment
  – Did not reveal significant difference in re-rupture rates with operative vs. non-operative (contrary to earlier beliefs)
  – Functional rehabilitation and early mobilization favored vs. prolonged immobilization
  – Trend towards earlier return to work, sport, and higher patient satisfaction levels due to earlier mobilization and functional rehabilitation

Achilles Tendon Rupture-Operate or Not? What does the literature say?

  – Multiple studies support early mobilization and functional rehabilitation
  – Early mobilization can have an influence on tissue healing
  – Early mobilization and WB not increased risk for re-rupture or complications
  – Early mobilization and functional rehabilitation resulted in better quality of life and patient satisfaction
  – Strength return takes a very long time and some never get it back
  – There is no optimal rehabilitation protocol
Achilles Repair Surgery

• Variety of procedures exist
• Allograft
• Tendon augmentation- Peroneus brevis, flexor digitorum longus, gracilis, FHL
• Synthetic graft
• Repair of the achilles without tendon augmentation
• Depends on condition of tissue at time of repair
• Sometimes trouble with wound healing occurs

Achilles Repair Surgery

• Patient is usually placed in a cast or splint for the first 2-6 weeks (depending on the MD) in plantar flexion

• NWB

• Monitored by MD for wound healing and tissue healing

• Using crutches, walker, or knee scooter
Achilles Repair Post-Operative Rehabilitation Phase I

• Usually initiated about 4-6 weeks post operative, sometimes 8 weeks (MD dependent)

• Now in a walking boot, may be partial weight bearing

• Heel lifts in walking boot

• Early mobilization recommended (*Holm 2015, Mark-Christensen 2016*)

• Ankle ROM-alphabet, Inversion/eversion,

• Self dorsiflexion stretch

• Heel toe rocks

• Towel scrunches

• Soft tissue mobilization, scar massage (healed), forefoot mobilizations

Self Dorsiflexion Stretch
Achilles Repair Post-Operative Rehabilitation Phase I

- Seated BAPS, Heel/Toe rocks on dynadisc, towel sweeps
- Passive heel cord stretching
  - Sometimes prohibited this early depending on the physician, make sure you have clear instructions about their preference
  - If permitted seated with a towel is a good way to start even just to get to neutral, do not force DF ROM
  - Tibialis stretching with a towel

Tibialis Stretch with a Towel
Achilles Repair Post-Operative Rehabilitation Phase I

• Stationary bike or NuStep, may need start in the boot if early in the process
• Consider strengthening of the hip and thigh
  – Straight leg raises
  – SAQ, LAQ
  – Clam shells, hip series
  – Hamstring curls

Achilles Repair Post-Operative Phase II (6-12 weeks)

• Progress WB in the boot and continue to wean off crutches

• Wean to a shoe once comfortable walking in boot w/o crutches (1 hour a day), patient has to be able to get the foot to neutral in WB comfortably

• Shoe with heel lift(s)

• Progression of stretching to WB flat surface first then progress toward incline (careful)
Achilles Repair Post-Operative Phase II (6-12 weeks)

- Initiate gait training
  - Treadmill, unloading system (Vigor, Anti-gravity treadmill)

- Aquatic therapy if available and incision healed

- Standing mini squats-can use to work on DF ROM as well, consider some mobilization with movement if patient is “stuck”

- Seated calf raises-can always add weight

- Leg press bilateral and single leg

Seated Calf Raises off a Step with Weight
Ankle Dorsiflexion Mobilization with Movement

Achilles Repair Post-Operative Phase II (6-12 weeks)

• Typical ankle Theraband exercises
• Begin calf raises progression
  – Shuttle 2 leg in neutral->shuttle single leg in neutral->shuttle 2 leg in DF-> shuttle single leg in DF-> standing 2 leg in neutral-> neutral 2 up 1 down->single leg (Mullaney et al Sports Health 2011)
  – Majority of patients can have residual weakness even 1 year after treatment (Silbernagel et al JOSPT 2012)
• Step-ups/lateral step-downs/forward step downs
• Single leg balance-age appropriate of course
  – Level surface first
  – Progress to BOSU, Rockerboard, Foam, Perturbations, Rebounder
Calf Raises on Shuttle to Neutral

Single Leg Calf Raise on Shuttle to Neutral
Achilles Repair Post-Operative Phase III (13 weeks +)

- Difficult phase, especially clinically, use resources i.e. school ATC, PREP program, gym, personal trainer
- No solid comprehensive measures for return to play decision making

**Return to running criteria (Saxena *J Foot Ankle Surg* 2011)**
- Perform 5 sets of 25 single-legged heel raises
- Calf circumference=5mm or less difference measured 10 cm distal to the tibial tuberosity of the operative limb vs. non-operative limb
- Ankle DF and PF ROM within 5 degrees of the non-operative limb
Achilles Repair Post-Operative Phase III (13 weeks +)

• Other Functional Testing-
  – Modified Star Excursion Balance Test
  – Repeated Step Down test
  – Calf Endurance test (Repeated heel raises one side at a time with normal considered to be about 25 repetitions)
  – Single leg balance eyes closed/open
  – Single leg hop testing

• Single leg balance on uneven surfaces (BOSU, dynadisc, rockerboard)
• Jogging in Sports Cord/Resistance Cord/shuffle
• Agility type drills
• Initiate plyometrics on the shuttle
  – Bilateral hops>single leg hops
  – Repeated hops for time to work on endurance
  – Alternate hop and land on opposite foot
  – Progress to hops in WB-bilateral to single leg, rotational, lateral
Alternate single leg hop and land on shuttle

Alternate ski hop jumps on the shuttle
Four Square Hop on Shuttle

Single leg hop on shuttle
Return to Sport Criteria

• Literature review revealed 80% reported return to sport however studies with measures describing determination of return to sport reported lower rates (Zellers et al 2016 Brit Journal of Sports Med)

• 90% Single leg hop testing

• 90% symmetry Y balance

• Patient confidence

• MD clearance

Rehabilitation After Posterior Tibial Tendon Repair

• Procedure to correct Tibialis Posterior Tendon Dysfunction (TPTD)

• TPTD
  – Most common cause of acquired flat foot deformity in adults
  – A condition characterized by a broad range of progressive disorders ranging from tenosynovitis to tendon rupture
  – Can have hindfoot collapse to a fixed, rigid flat foot deformity
Posterior Tibial Tendon Repair Procedure

• Primary repair-for acute tears, usually end to end suture

• Synovectomy-basically a debridement of the tendon and sheath, helps to prevent complete rupture

• Tendon Transfer-Flexor digitorum longus, some strict guidelines for this procedure to be successful

• Calcaneal osteotomy-calcaneus shifted medial to place hindfoot in a more varus position

• Arthrodesis-Can come at a cost of flexibility of the foot
Posterior Tibial Tendon Repair Phase I (0-up to 8 weeks)

• Usually first 4 to up to 8 weeks depending on the physician the patient is immobilized in a cast

• Can work on upper body strength, hip and thigh strengthening and flexibility

• Wiggle toes in the cast

Posterior Tibial Tendon Repair Phase II (6-12 weeks)

• Patient now in boot usually WBAT

• Initiate some light stretching of the gastric soleus muscles-long sitting with a towel

• Towel scrunches

• Seated BAPS, rockerboard, heel/toe rocks

• Stationary bike

• Soft tissue mobilization

• Ankle isometrics progressed to ankle TB
Posterior Tibial Tendon Repair Phase II (6-12 weeks)

- Once comfortable weight bearing continue to progress exercises in weight bearing
- Gait training
- Aquatic therapy if available
- Leg Press
- Calf raise progression on leg press or shuttle, then progress to standing

Posterior Tibial Tendon Repair Phase III (12 weeks +)

- Advance proprioception as able
- Progress calf raises in standing to single leg
- Step downs forward, lateral, step up and over
- SC walkouts, walkouts over hurdles
Posterior Tibial Tendon Repair Phase III (12 weeks +)

• Return to running/sport
  – No real formal guidelines in the literature currently (at least that I could find when searching)
  – Discuss with your surgeon
  – Risk/Reward/Age of patient
  – Consider typical lower extremity functional testing and return to jog guidelines discussed previously

References

Thank You!
Rehabilitation Following Surgical Procedures of the Forefoot

Hallux Valgus/Bunionectomy Correction, Lisfranc Stabilization
Darrell Allen, PT, DPT, SCS

Hallux Valgus Prevalence

- Hallux valgus is very common
- Prevalence of hallux valgus 23% in adults age 18-65
- 35.7% in adults over age 65 (Nix et. al 2010)
Hallux Valgus Prevalence

- Coughlin and Jones (2007) reviewed 122 feet with hallux valgus:
  - 83% familial history (intrinsic predisposition that then may be activated by other factors)
  - Bilateral presence in 84% of their population
  - 71% round metatarsal head, 71% long first met.
  - 92% female
  - Constrictive shoes/occupation played a role 34%

What is Hallux Valgus

- Medial deviation of the first metatarsal
- Lateral deviation and/or rotation of the hallux
- Prominence, with or without medial soft-tissue enlargement of the first metatarsal head
Hallux Valgus Etiology

• Biomechanical Causes
  – Excessive foot pronation/midfoot mobility
    • Ankle/forefoot equinus
    • Pes planovalgus (rigid or flexible)
    • Forefoot Varus (rigid or flexible)
    • Dorsiflexed first ray
    • Hypermobility

Biomechanical Causes

• Excessive Pronation
  – Some pronation is normal
  – Excessive pronation causes excessive midfoot mobility
  – Inability of the foot to re-supinate and create a rigid lever at push off
  – Result is a dorsiflexed first ray (should be plantarflexed)
  – Reduced 1st MP dorsiflexion occurs at push-off
Biomechanical Causes

• Normal propulsion 65 degrees of dorsiflexion is needed at the first MTP joint
• Only 20-30 degrees available from hallux DF
• First metatarsal must plantarflex to achieve the additional 40 degrees needed
• Excessive pronation late in the gait cycle prevents plantarflexion of the metatarsal
  – Creates a jamming effect of the first MTP

Biomechanical Causes

• Forced dorsiflexion of the first MTP joint on a pronated midfoot creates intense pressures at the first MTP
• If adequately hypermobile
  – metatarsal drifts medially
  – hallux drifts laterally (causing hallux valgus)
  ▪ If the mid-foot is rigid hallux rigidus will occur
Hallux Valgus Treatment Options

• Conservative Treatment Options
  – Physical Therapy
  – Orthotics
  – Shoe modification
  – Injections (1st MP joint)

• Surgical Correction
  – Done if conservative treatments fail or patient elects surgery for cosmetic reasons.

Determination of Surgical Procedure

• Procedure chosen to treat hallux valgus deformity determined by:
  – Severity of the deformity
  – Magnitude of the inter-metatarsal angle

• Mild-moderate deformities: distal first metatarsal osteotomy: Chevron osteotomy- preferred method (Choi et al 2018)
• Severe deformity: proximal first metatarsal osteotomy
Inter-metatarsal Angle  HAV Angle

Chevron Osteotomy

- Indicated for mild-moderate hallux valgus deformities
- Medial eminence of the first metatarsal head is excised
- 60 degree V osteotomy centered on the first metatarsal head
- Capital fragment displaced laterally, fixed with screw
Proximal First Metatarsal Osteotomy

- Indicated for moderate to severe deformity
- May be done in conjunction with a distal osteotomy and or soft tissue procedure
- Several different types of proximal procedures exist (Chevron, Akin, Double)

Physical Therapy Following Hallux Valgus Correction/Bunionectomy

- Physical therapy is often under utilized after hallux correction surgery
- Physical therapy is indicated to
  - help reduce disability resulting from surgery
  - Restore normal biomechanics (possibly also addressing faulty biomechanics that led to the hallux valgus)
  - Reduce symptoms
  - Assist and guide the return to regular activity

Hawson 2014
Physical Therapy Following Hallux Valgus Correction/Bunionectomy

• Physical therapy has been shown to improve function after hallux valgus surgery

Post-Operative Recovery Hallux Valgus Correction/Bunionectomy

• NWB at the medial foot/first MTP joint for approximately 4 weeks
• Post-operative open toe orthopedic shoe
• Crutches, knee scooter, or ambulation on heel
• Management of post-operative swelling (ice), pain, operative site healing
Rehabilitation Considerations

• Restore Normal:
  – Weight bearing at the medial foot
  – Gait
  – First MTP mobility/ROM (extension)
  – Intrinsic foot muscle strength
  – Balance
  – Functional strength involved LE
  – Return to normal function

Lisfranc Joint Anatomy

• The Lisfranc joint includes all articulations between the tarsal bones (3 cuneiforms and the cuboid) and the bases of the 5 metatarsals.
  • Excellent osseus stability
  • Typically rigid
Lisfranc Ligament

- The Lisfranc ligament is a thick oblique ligament extending from the base of the second metatarsal to the plantar aspect of the medial cuneiform.

Lisfranc Injury

- Lisfranc dislocations and fracture dislocations are considered rare
  - 43% occurred during motor vehicle accidents
  - 10% during sporting activity
  - 13% due to crush injuries
  - 24% from falls, jumps, and twisting injuries
Lisfranc Injury Mechanism in Sports

• The second ray is engaged in the turf, and hyperdorsiflexion of the metatarsophalangeal joints occurs.

Lisfranc Injury in Sports

• Lisfranc ligament tear creates instability of the midfoot.
• **Stage 1** injuries represent a midfoot/Lisfranc “sprain,” with no diastasis or loss of the arch height but a positive bone scan finding, indicating an injury to the dorsal ligaments/capsule, but the plantar Lisfranc ligament is spared.
• **Stage 2** injuries are associated with 2 to 5 mm of diastasis between the first and second metatarsal bases without collapse of the arch height.
• **Stage 3** injuries are represented by greater than 5-mm diastasis and collapse of the arch height.
Lisfranc Stabilization Surgery

- Patients who have any instability (presence of diastasis or subluxation on imaging), severe dislocations, or injury associated with a compartment syndrome require operative stabilization.

- For predominantly ligamentous injuries, the traditional gold standard has been interosseous transarticular solid screw fixation to rigidly hold reduction while the ligament heals. (Lewis et al. 2016)
Lisfranc Stabilization Post-Operative Guidelines

- Non-Weight Bearing 6 weeks post surgery
- Progressive weight bearing in a boot at 6 weeks post-op.
- Transition to a normal shoe at 3 months
- May initiate aquatic therapy when wounds are healed
- May initiate stationary bike at 4 weeks
- Higher level athletes may be permitted to run as soon as 12 weeks post-op, but no cutting and sprinting until 16 weeks.
  – Lewis et al. 2016

Rehabilitation Following Surgical Procedures of the Forefoot

Weight Bearing Progression

- Progression from protective shoe to regular shoes: approx. 4 weeks post-op (Hallux Valgus), 12 weeks post-op (Lisfranc) may vary depending on procedure performed
- Drills focusing on initiating progressive weight bearing through the operative foot
  – Emphasize even wt. bearing whole foot
  – Comfort bearing wt. through the medial foot
Weight Bearing Transition

- **Weight shifting**: (frontal plane, sagittal plane)
- **Stepping Drill**: involved foot stationary as the patient steps in front and behind the body with the uninvolved- transition wt. through involved LE.
- **Gait Training**
  - *Walking forward* - heel toe cues, even wt bearing
  - *Marching slow* - incorporates mild balance
  - *Side-stepping* - emphasize push off with forefoot
  - *Backward walking*: more advanced and requires 1st MP extension and load, this is a progression when ready

First MTP ROM
(Hallux Valgus Procedure)

- Normal gait requires 55-60 degrees of hallux metatarsalphalangeal extension.
- Decreased mobility of the first MTP joint due to immobilization, swelling, etc. may limit ability to ambulate with a normal push off (may result in abnormal gait compensations)
- **Joint Mobilization**
  - General distraction (flexion and extension)
  - Dorsal (flexion), plantar (extension)
- **Manual PROM**
  - Extension at 1st MTP (do with distraction)
- **Soft tissue mobilization/massage** (scar when healed)
ROM/Mobilization

• Talocrural (ankle) mobilization
  – General distraction
  – Anterior/posterior mobilizations
  – Mobilization with movement
  – Goal to restore adequate ankle
    DF for gait
• Subtalar Joint Mobilization
  – Subtalar joint eversion
• Gastroc/Soleus flexibility

Foot Intrinsic Strengthening

• Initiate deep intrinsic muscle strengthening in sitting “TOGA”
  – Doming
  – Toe adduction/abduction
  – Great toe extension with other 4 toes pressed to floor
  – 2nd-4th toe extension, 1st+5th on floor
  – Toe curls (towel)

• Standing foot doming:
  – Doming in bilateral stance
  – Doming in single leg stance
  – Doming during dynamic
    balance or strengthening
    exercises (IE. Steamboats, juggling, etc)
Balance Progression

• The balance progression is intended to help patients become comfortable bearing full weight through the involved foot.
• Emphasize even weight distribution through the foot
• Watch compensations (lateral weight lean)
• Single leg balance: partially supported, un-supported, unsteady surfaces, perturbations
• Dynamic single leg balance: Steamboats, juggles, rebounder throws, etc.

**Do not progress unless they are able to bear weight evenly on the involved foot (medial column) with good comfort and ability.

Multi-Plane Functional Exercise

• Goals of multi-plane functional exercise
  – Establish ability and comfort with transitioning and shifting weight through the foot in all planes of motion
  – Improve foot and LE strength
  – Improve proprioception
  – Improve confidence with variable movements that may carry over to daily activities, sports, and recreation
  – Address the entire LE kinetic chain

• Start with the forward sagittal plane, progress to the frontal plane, transverse plane, and lastly retro sagittal plane movements (requires significant 1st MTP extension with a load)
Multi-Plane Functional Exercise

• Squats
  – Regular feet shoulder width stance
  – Right stance (right foot forward stagger stance)
  – Left stance (left foot forward stagger stance)
  **Add arm, dumbbell, or medicine ball reaches to drive weight distribution and loading in desired direction**

Multi-Plane Functional Exercise

• Lunges: (30-45 degrees knee flexion)
  – Anterior- allow weight to transfer fully to front LE
  – Lateral- load lunging leg and push off to return to start
  – Anterior-lateral diagonals- variable medial foot loading
  – Posterior (this will require the greatest challenge to forefoot and first MTP loading)
  **Add arm, dumbbell, or medicine ball reaches (medial, lateral, high, or low), vary the speed to challenge foot and LE loading.**
Multi-Plane Functional Exercise

• Balance and Reach
  – Anterior: starting point, mild forefoot load
  – Anterior or posterior medial: progresses to greater medial foot loading
  – Medial: greatest medial foot loading- watch for avoidance (keeping wt. on lateral foot)

Multi-Plane Functional Exercise

• Step-Ups
  – Progression:
    • Forward
    • Lateral (can then go to lateral up and over and back)
    • Retro (backward leading with involved- start 2-4” step as this requires significant 1st MTP/forefoot loading)

• Step-Downs (eccentric lowering with involved leg as stance leg)
  – Medial: allow pronation at foot/knee
  – Anterior-medial: shifts greater weight to the medial forefoot
  – Anterior: weight shift toward forefoot
  – Medial-rotation or posterior-medial rotation:
    • increases pronatory forces to medial foot (control and normal motion are the focus)
Sports and Impact Loading Progressions

• Typically impact loading of the foot will not be permitted by the surgeon until around 3-4 months post-op (may vary depending on the procedure)
• Impact loading may begin with low intensity pre-running drills to determine tolerance
  – Side shuffling, carioca jog, skipping, etc.
• Running: progress gradually (Run:walk program is ideal gradually increasing running duration/volume over 6-8 weeks)
• Plyometrics and aggressive cutting should be progressed gradually only after success and tolerance of at least 1 month of running/light agilities.

Orthotic Considerations

• Hallux Valgus/Bunionectomy Correction
  – Orthotics may be indicated to address biomechanical abnormalities that contributed to the cause in the first place
  – Control excessive pronation/medial collapse (provide stability to foot and motion control)
  – Hallux/first ray considerations
    • May be normal
    • Morton’s extension if hallux limitus
    • First ray or 1st MP cut out if wish to enhance first ray plantarflexion and 1st MP extension

• Lisfranc Stabilization
  – Provide total contact and stability under the foot/forefoot (semi-rigid device)
  – Address biomechanical abnormalities if they exist
  – Comfort with activity
Shoe Considerations

• Adequate room in the toe box (width)
• Greater stiffness/stability of the last (especially early on)
• Proper fit and general comfort
• May gradually progress to any shoe over time as tolerance permits (yes, even high heels!)

Pain/Scar Management Considerations

• Post-operative pain
  – Rest (stay off feet as much as possible)
  – Elevate
  – Ice (ice pack 20 min each hour week 1)
• Pain considerations in subacute and advanced stages of recovery
  – Progress activity gradually
  – Reduce activity levels if pain increases
  – Continue to ice 1-3 x daily as pain persists (ice massage 5 min)
• Scar management
  – Acute stage: keep incision site clean (look for signs of infection)
  – Once the incision is healed scar massage/mobilization, vitamin C/silicone gel can help to achieve scar mobility and potentially reduce the thickness of the scar
Cleveland Clinic

Every life deserves world class care.