Fracture to Arthroplasty: Management Strategies at the Ankle and Hindfoot

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ROSALIND FRANKLIN UNIVERSITY OF MEDICINE AND SCIENCE
REGIS UNIVERSITY
School of Medicine
UNIVERSITY OF COLORADO ANSCHUTZ MEDICAL CAMPUS

CSM APTA Combined Sections Meeting 2018 #APTACSM

Disclosure

- We have no relationships that could reasonably be viewed as creating a conflict of interest, or the appearance of a conflict of interest, that might bias the content of the presentation.

Session Learning Objectives

- Review current evidence on outcomes for patients with ankle and hind foot fractures, as well as post-traumatic arthritis.
- Identify treatment approaches for managing patients with complex hind foot and ankle fractures, as well as post-traumatic arthritis.
- Recognize surgical indications for total ankle arthroplasty and understand post-operative rehabilitation guidelines
- Recognize the clinical presentation and biomechanical characteristics of patients with post-traumatic arthritis who may elect total ankle arthroplasty
- Present a case study highlighting the progression of physical therapy management following hindfoot fracture to management post total ankle arthroplasty

The Continuum of Outcomes following Hindfoot and Ankle Fractures

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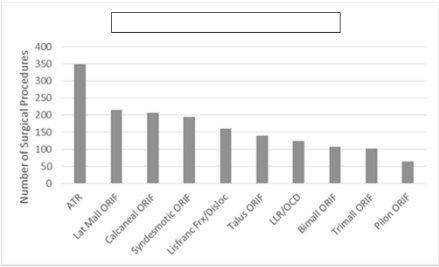
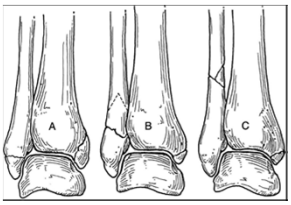
Surgical Procedures 2012-16



Ankle Fractures

- Types:
  - Weber fractures
  - Pilon fractures
  - Maisonneuve fractures
    - Weber C, syndesmotic, deltoid involvement



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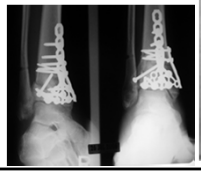
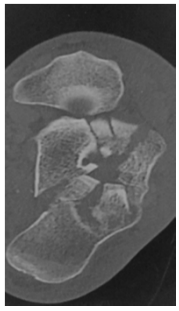


Hindfoot Fractures

- Talus
  - Lat process fractures
  - Neck fractures
    - Hawkins I-IV
  - Body fractures
  - Fractures of the head
  - Combination
  - Osteochondral fractures
- Calcaneus
  - Posterior facet
  - Tongue-type fractures
  - Ant Process fractures



History

- What was the mechanism?
  - Sports? Fall (how far)? MVA? Stairs? Ice?
- What direction did the foot/ankle go?
  - Inversion or Eversion?
  - Plantarflexion or Dorsiflexion?
  - Combined?
- Hear or feel pop or snap?
- Able to weight bear after?

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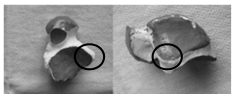
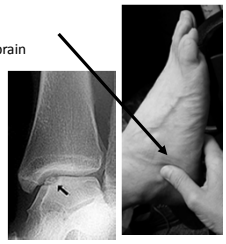
Examination

- Palpation – specific location of tenderness
  - Proximal Fibula
  - Deltoid/syndesmosis
  - Unstable - Surgery

Examination

- Palpation – specific location of tenderness
  - Proximal fibula
  - Anterior process of calcaneus
    - Mechanism of injury similar to ankle sprain (inversion)
  - Lateral process of talus
  - Talar dome





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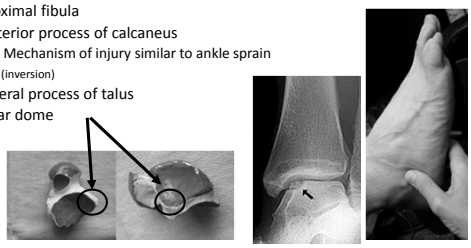

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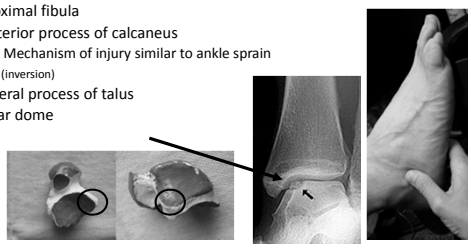


Be Specific

- Several structures in small area:
  - Ant process calc
  - CC joint
  - Bifurcate lig
  - Sural n
  - Ext dig brevis

Examination

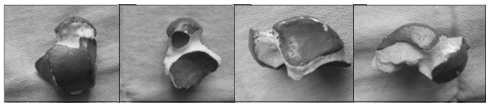
- Palpation – specific location of tenderness
  - Proximal fibula
  - Anterior process of calcaneus
  - Lateral process of talus
  - Talar dome
  - **DOES MECHANISM MATCH WHERE PATIENT IS TENDER?**

Expectations

- Clear expectations aide in satisfaction
- Patients with depressive and anxiety symptoms have greater expectations and more expectations from foot and ankle surgery (Cody, 2017)
- "Discussions with surgeons about what to expect from surgery tend to be brief and poorly recalled." (Cody, 2017)

Talar Fractures

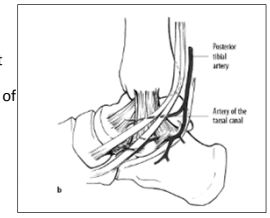
Talus - Anatomy



- 60% of talus is covered by articular cartilage
- 7 articular surfaces

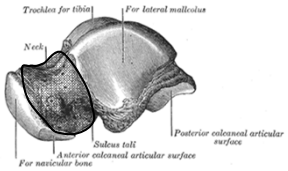
Talus - Anatomy

- Vascular supply derived from artery of tarsal canal, deltoid artery, and sinus tarsi artery
- Decreased trabecular content of neck and oriented in different direction than bone of talar body and head
- Ankle and subtalar mobility along with medial column support depend on the anatomical integrity of talus



Background

- Hawkins Classification – talar neck fractures classified according to degree of displacement
  - Type I – IV (less severe to most severe)
- Lateral process fractures – (may present similar to ankle sprain)
- Talar body fractures
- Talar head fractures



Background

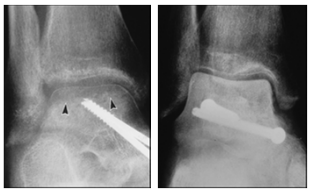
- Complications:
  - AVN
  - Posttraumatic arthritis
  - Varus deformity
  - Loss of motion

Outcomes – Talar Fractures

- Talus fractures described as early as 1608 by Fabrizius
- 1848 Syme reported 11 deaths out of 13 cases with open talus factures
  - Advised primary amputation in those cases
- Despite modern advances, continue to be challenging fractures to manage
  - Osseous
  - vascularity

Outcomes – Talar Fractures

- SR 2013 Talar neck fractures (Halvorson)
  - AVN – 33%
  - Malunion – 17%
  - Nonunion – 5%
  - Post-traumatic arthrosis – 68%
  - Self-reported outcomes
    - 20% Excellent
    - >50% fair or poor
- SR 2017 Talar neck fractures (Jordan)
  - AVN – 26%
  - Malunion – 13%
  - Nonunion – 4%
  - Post-traumatic arthrosis
    - TC joint – 52%
    - STJ – 45%
  - Self-reported outcomes
    - 70% fair to good

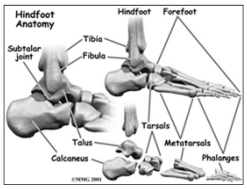


Outcomes – Osteochondral Lesions of Talus

- Occur in 50-70% of acute ankle sprains/fractures (Gianakos, 2017)
- Causes:
  - Trauma
  - Congenital
  - Ligamentous laxity
  - Steroid treatment
  - Embolic disease
  - Endocrine abnormalities
- Clinical presentation:
  - Persistent ankle pain after sprain
  - Generalized ankle swelling, stiffness, weakness associated with prolonged WB

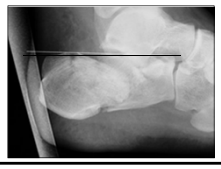
Calcaneal Fractures

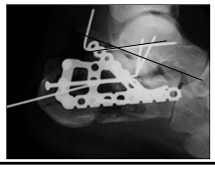
- Calcaneus most commonly fractured tarsal bone (Griffin, 2014)
  - 17,274 in US in 2010
- Significant socio-economic burden
  - $28.5-$40.5 mill/year
- Forces of 300% to 400% of BW transmitted through hindfoot (Balazs, 2014)
- Affect mostly young working persons (Eckstein, 2016)
- Poor clinical outcomes common after



Calcaneal Fractures

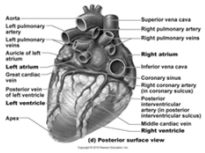
- Calcaneal fractures associated with other trauma (Renovell-Ferrer, 2017)
  - 40% of cases
    - 10-20% spine
    - 10% Bilateral calcaneal fractures





Outcomes – Calcaneus Fractures

- 2-8 yr fu (Van Tetering, 2004)
- SF-36
- Normative data
- Ortho
- Medical condition
  - Heart, lung, liver transplants, myocardial infarctions



humananatomybody.info

Outcomes

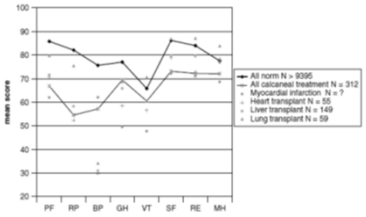


Fig. 3: Normative data compared to patients with a displaced intraarticular calcaneal fracture and other disease entities. PF = physical functioning; RP = role physical; BP = bodily pain; GH = general health; VT = vitality; SF = social functioning; RE = role emotional; MH = mental health.

Van Teetering, 2004

Outcomes – Calcaneus Fractures

- 244 fractures, 2 year follow-up
- Short Form 36 (SF-36), visual analogue scale (VAS), and a gait analogue score measured patient satisfaction
- Subtalar joint motion - percentage of uninjured limb
  - grouped into quartiles
- VAS, SF-36 ($p < .0001$), and the gait satisfaction score ($p < .05$) all increased significantly with increased STJ motion

Kingwell, et al Foot and Ankle Int 2004

Outcomes – Calcaneus Fractures

- Younger patients (<39 yrs) have worse self-reported outcomes (Golos, 2015)
- Several factor influence outcomes (Eckstein, 2016)
  - Initial severity of soft tissue and concomitant injuries
  - Age
  - BMI
  - Diabetes
  - Nicotine use
- One study – 10% of patients required STJ arthrodesis due to post-traumatic arthritis within 14 months from surgery (Eckstein, 2016)

Outcomes – Calcaneus Fractures

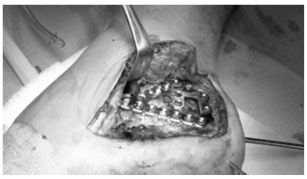
- Outcomes of study with 20 yr follow-up after ORIF(Eckstein, 2016)
  - AOFAS hindfoot score
    - 55% had good to excellent results and 45% had fair to poor results
  - Average time off work – 7 months (range 2-12)
  - 30% required modified shoewear
- Severity of injury significantly related to AOFAS scores and SF-36 scores (Renovell-Ferrer, 2017)
- Patients with psychiatric comorbidities presented worse health-related quality of life (Renovell-Ferrer, 2017)

Outcomes – Calcaneus Fractures

- Stiffness
  - TC
  - STJ
  - TN joint
  - Midft
  - FF
- Gait deviations (Hirschmuller, 2010)
  - Velocity correlates with AOFAS scores
- Loss of postural control (Hirschmuller, 2010)
- Literature mixed regarding starting motion early vs late
  - Some advocate early
  - Other late due to infections

Background

- Complications
  - Deep wound infection (depends on institutional frx load – Poeze, 2008)
  - HWR
  - Superficial wound complications
  - Peroneal Tendon (Tufescu, 2001)
  - Limitations in ROM (approx 50% of STJ)
  - Non/Malunions
  - Persistent Pn
  - Early post-traumatic OA

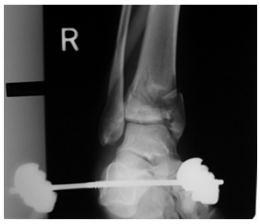


Management Calcaneus Fractures

- Early post-traumatic arthritis of STJ
  - Conservative tx: orthotic devices, modified shoe wear, anti-inflammatory medications, assistive devices
  - Surgical tx: arthrodesis

Outcomes – Pilon Fractures

- High-energy axial type injuries to weight-bearing surface distal tibia
  - Low-energy rotational injuries
- Associated with joint surface comminution, displaced fracture fragments, soft tissue trauma
- Significantly poorer quality of life compared with age and gender-matched norms at 8 year follow-up (Cutillas-Ybarra, 2015)
  - Decreased TC joint ROM
    - Injured side – 35.2° ±18.3°
    - Uninjured side – 60.3° ±9.9°
  - VAS for pain during walking 5.8 (range, 0-10)
  - Significant decrease in mental component summary for patients who had decreased ankle motion compared with uninjured ankle



Outcomes – Pilon Fractures

- 43% of patients unable to return to work after pilon frx (Thomas-Hernandez, 2016)
- 26% (17 of 64) of patients develop post-traumatic arthritis at ave 7.7 months after surgical fixation (Lomax, 2015)
  - 2 required arthrodesis within first post-op year
- Within 2-3 years, 40% of patients demonstrated radiographic ankle arthritis (Coetzee, 2010)

Outcomes – Weber Fractures

- Malleolar fractures are the most frequent type of ankle fractrues presenting in 40-50% of patients with end-stage ankle arthritis
- Posttraumatic arthritis directly correlated with fracture pattern
  - Weber A incidence – 4%
  - Weber C incidence – 33%

Ankle Arthritis

- Rates of ankle arthritis (4%) low compared to hip (19%), knee (41%) (Coetzee, 2010)
- Primary arthritis of the knee is 70%, of the hip is 60% and of the ankle is 20% (Liang, 2017)
- Normal gait over level ground increases the load on the ankle jt to 5 times body weight (Thomas, 2003)
  - Ant/lat dome accepts majorty of this weight
  - Med and lat facets accept rest of load with medial 2 times > lat facet
- At 50% of gait cycle, talus is in neutral to slight DF position and contact area is greatest (Thomas, 2003)
- In PF, contact area diminishes by 13-18% (Thomas, 2003)
- Pathologic conditions affect the tibiotalar contact area (Deland, 2005)
  - 1 mm of lateral displacement of the talus decreased tibiotalar articulation by 42%

Biomechanics and Treatment Approaches of Post-traumatic Ankle Arthritis

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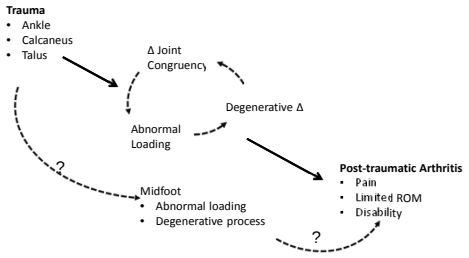


1) How does post-traumatic hindfoot arthritis affect ankle and midfoot biomechanics ?
2) How can the evidence to date inform practice

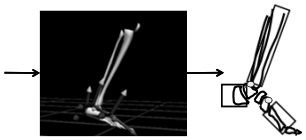
references

Study Sample

- Inclusion Criteria
  - Unilateral end stage ankle arthritis
  - Candidate for total ankle replacement

	Sample (N=12) Mean (SD)
Age (years)	XX
Gender (% male)	XX
Body Mass Index (lb/in^2)	XX

Procedures - Foot Model



- 3 Segments - Forefoot, Rearfoot, Tibia
- Self selected walking speed
  - Range:
- Involved to uninvolved limb comparisons

Ankle Motion and Power

Dorsiflexion / Plantarflexion Motion

Inversion / eversion Motion

Plantarflexion Power

Midfoot Motion and Power

Dorsiflexion / Plantarflexion Motion

Adduction / Abduction Motion

Plantarflexion Power

Ankle ROM During Walking (DF / PF ROM°)

Early Stance

Midstance

Terminal Stance

Ankle ROM During Walking (Inv / Ev ROM°)

Early Stance

Midstance

Terminal Stance

Ankle Power

Midfoot ROM During Walking
(DF / PF ROM°)

Early Stance Midstance Terminal Stance

Midfoot ROM During Walking
(ADD / ABD ROM°)

Early Stance Midstance Terminal Stance

Midfoot Power

Summary - Ankle and Midfoot Biomechanics

Ankle **Midfoot**

Treatment Approaches

Clinical Presentation

- Perceived Function / Quality of Life
  - Foot and Ankle Ability Measure
  - Lower Extremity Functional Scale
  - Short-Form 36
- Pain
- Stiffness
- Imbalance / Falls

Pain - Assessment

- Pain
  - Visual Analog Scale
  - Numeric Pain Ring Scale
  - Pressure pain thresholds

Pain - Intervention

- Alleviating
  - Joint mobilization
    - Conditioned pain modulation
- Accommodative
  - Bracing
  - Footwear modification
  - Weight management
  - Activity Strategies

Stiffness and Strength

- ROM
  - Maintain as possible
  - Low load repetitive motion
- Strength
  - NWB and WB
    - Intrinsic / extrinsic foot muscles
    - Proximal strengthening
      - Hip extension for propulsion

Gait / Imbalance - Assessment

- Gait
  - Six minute walk test
    - Slower
    - ⬇ stride length
- Imbalance
  - Single Leg Stance
  - Sit to stand
  - Four Square Test

Gait / Imbalance - Assessment

- Gait
  - Six minute walk test
  - Slower, decreased stride length
- Imbalance
  - Single leg stance
  - Sit to stand
  - Four Square Test

Summary - Treatments

- Pain management
  - Accommodative > Alleviating
- Stiffness and Strengthening
  - Maintain ROM, chondral training
  - Prehab: intrinsic / extrinsic foot muscles + proximal muscles
- Gait / Imbalance
  - Safety, static and dynamic training, adaptive strategies
- Contralateral leg

Rehabilitation and Outcomes Following Total Ankle Arthroplasty

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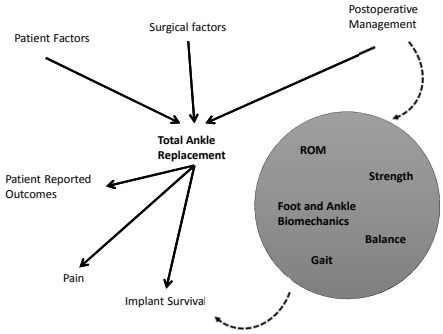

Factors Affecting Outcomes

Patient
- Co-morbidities
- BMI
- Psychosocial
- Pre-operative status
  - ROM
  - Strength

Operative
- Candidate selection
- Surgeon experience
- Implant Type
- Complications

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Factors Affecting Outcomes

- Postoperative Management
  - Weightbearing progression
  - Compression wrapping
  - Physical Therapy?
    - Not always the standard of care

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Study Design

- Prospective cohort study
  - 6 month follow up
  - Inclusion Criteria
    - Unilateral end stage ankle arthritis
    - Candidate for total ankle replacement
- Two fellowship trained foot & ankle surgeons
- Implant type
- Postoperative management was not controlled

Study Sample

	Sample (N=12) Mean (SD)
Age (years)	XX
Gender (% male)	XX
Body Mass Index (lb/in^2)	XX
Length of hospital stay (days)	XX
PT Sessions (visits)	XX
PT Duration (days)	XX

Outcomes

- Pre to Post Comparisons
  - Pain
  - Foot and ankle Ability Measure
  - Six Minute Walk Test
  - Isokinetic Ankle Strength
  - Ankle and Midfoot Biomechanics During Walking

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Postoperative Management

- Weightbearing progression
- Compression Wrapping
- PT Interventions

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Postoperative Management

- Weightbearing progression
- Compression Wrapping
- PT Interventions

69

Postoperative Management

- Weightbearing progression
- Compression Wrapping
- PT Interventions

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Outcomes – 6 Months

Pain

Foot and Ankle Ability Measure

Six Minute Walk Test

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Outcomes – 6 months

Ankle ROM

Ankle Strength

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Outcomes – 6 months

Ankle ROM During Walking

Ankle Power

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Outcomes – 6 months

Midfoot ROM During Walking

Midfoot Power

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Outcomes - Midterm

- Pain
- Functional outcome measures
- Gait

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Outcomes - Midterm

- Ankle ROM
- Ankle Power During Gait
- Balance

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Outcomes

- Implant Survival

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Case Study: From Fracture to TAA

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Talus Fracture Case Study

Case Study – Talus Fracture

- 20 y/o male S/P Right talar body ORIF after fall climbing fixed on 3/1/2016
- Student at University of Utah
- Comminuted fracture of posteromedial portion of talus including both colliculi on either side of the FHL tendon with displaced fragments of both talocrural and subtalar joint
- No significant medical hx except for asthma

Case Study – Talus Fracture

- Post-operative plan:
  - NWB for 12 weeks
  - 2 weeks post-op sutures removed and placed in walking boot

Case Study – Talus Fracture

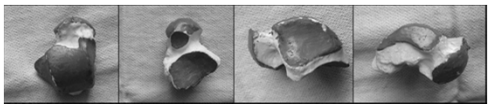
- Evaluation 5/23/2016
  - Chief Complaint:
    - Decreased activity (would like to return to hiking, climbing, golfing and running)
    - Non-compliant with WB status per MD
    - Pn 7/10 at worst, 0/10 at best, and 0/10 currently
      - Pn is "pinching" posterior to lateral malleolus with AROM in all directions
    - Neuro exam – intact
    - Incision – closed and no signs of infection
    - Off all pain medications
    - Figure of 8:
      - Left: 52 cm
      - Right: 53 cm
    - ROM:
      - DF to PF Left – 6 to 38
      - DF to PF Right – 0 to 21

Case Study – Talus Fracture

- Patient is allowed to begin WB at 10 weeks post-op since has been non-compliant in boot per MD
- Protocol:
  - Start at 25% WB and increase 25% every 7 days in boot
  - Once full WB for 2 weeks may slowly wean OOB (over approximately 7 days)

Case Study – Talus Fracture

- Patient came for 3 visits over 4 week period of time
  - Patient education regarding chondral issues and long term outcomes
  - Focused on chondral training, ROM, gait training, and balance
  - Patient continued to be non-compliant
    - Started rock climbing at 12 weeks post-op
    - Started hiking at 10 weeks post-op
  - Did not attend f/u visit



Case Study – Talus Fracture

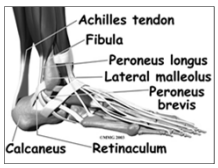
- 6 months post-op patient called to schedule another visit secondary to increased pain levels and increasing stiffness
- Re-eval
  - Pn 9/10 at worst, 2/10 at best and 4/10 currently
  - Able to go up stairs normally, but difficultly going down stairs secondary to pn and stiffness
  - Pain at terminal stance phase of gait
  - Increased pain in AM for approximately 5 min
  - Decreased pain if supinates

Case Study – Talus Fracture

- Re-eval (cont)
  - Swelling and TTP post and inferior to lateral mall
  - Eversion strength 4-/5 with pain
  - Gastroc strength 4-/5 with pain
  - DF and Inversion strength 5/5 pain free
  - SLS:
    - Left – 30 sec EO
    - Right – 6 sec and stopped secondary to pain
  - Knee to wall:
    - Left: +7 cm
    - Right: -3 cm
  - Antalgic gait pattern, decreased loading of midfoot and forefoot

Case Study – Talus Fracture

- Potential diagnoses?
  - Peroneal tendonitis
  - Subtalar joint OA



Case Study – Talus Fracture

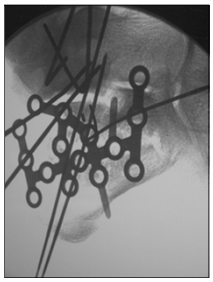
- Sent back to MD for a follow-up 2 weeks later:
  - X-rays demonstrated moderate STJ OA
  - Again discussed low-impact activities
  - Potential for STJ arthrodesis once symptoms intolerable
  - Bracing
  - Modified shoewear
  - Orthotics?

Talus Fracture - Rehabilitation

- ROM – caution with early forced DF due to anatomy of talus
- Swelling control (compression stocking)
- Chondral Training, Chondral Training, Chondral Training, Chondral Training (LOW LOAD, HIGH REPETITION)
- Pt education re: activity modification
- Usually don't start WB until 8-12 wks po
  - Strengthen LE

Rehabilitation

- First priority is **PATIENT EDUCATION**
  - Should hear from doctor first
  - Set realistic expectations
  - Life changing
  - Explain how their fracture is unique



Failed Conservative Treatment

- 69 y/o male with significant R post-traumatic arthritis of TC and STJ
- 12 weeks post Salto-Talaris TAA, STJ arthrodesis and TAL
- Self-employed, has worked from home since time of surgery
- NWB for 6 weeks post-op
  - Progressed 25% every 7 days as tolerated in walking boot
  - Weaned OOB once FWB for 2 weeks
- PMH: Significant for diabetes and high BP
- Goals:
  - Hiking
  - Biking
  - Walking for ex
  - One month hiking trip in Alaska 8 month post-op

Tests and Measures

- Active DF - 2° (knee extended)
- Active PF - 8° (knee extended)

} Total 10° AROM

- Inv/eversion not assessed
- Incision – closed and no signs of infection
- NPRS pn – 0/10 best, 0/10 current, 0/10 worst
- LEFS – 35
- Balance and proprio
  - SLS 1 sec EO affected side
  - SLS 5 sec EO unaffected side

Evaluation and Prognosis

- Pt full weight bearing and OOB 100% of the day with no increase in pn
- Felt nervous about falling in the community and would use cane for balance
- Calf strength no test secondary to Achilles lengthening
- Prognosis – overall good; however due to STJ fusion discussed some potential difficulties with hiking on uneven ground and balance
- Seen total of 8 visits over 19 weeks

Intervention

- Initial visit focus
  - AROM (PF and DF)
  - Balance and proprio B – tandem stance (EO, EC)
  - Gait training
  - Initiated gentle gastroc strengthening B
  - Added stationary bike for home
- 2 week follow-up
  - AROM improved from 10° to 19° of TC joint
  - Increased gastroc strengthening ecc
  - Balance – proressed to SLS activities and B stance on uneven surface
  - Increased functional strengthening
  - HEP – 4-5 exercises max

Intervention (continued)

- After one month – added independent walking program on treadmill and progressed to incline over next month
- Added walking on uneven surfaces on flat trails
- At 5 months post-op
  - Continued to progress SLS on uneven surfaces
  - Continued to progress gastroc strengthening
- At 6 months post-op
  - Began light hiking and progressed as tolerated in preparation for trip to Alaska

Outcomes

- Last visit - 8 month post-op prior to Alaska trip
  - Total AROM of TC joint 23°
  - Able to perform 10 uni HR
  - LEFS improved from 35 to 64
  - SLS improved to 10 sec B
  - Gait - Pedar

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