Charcot Arthropathy

Patient Evaluation and Indications for Surgery

Jeremy J. McCormick, M.D.
Assistant Professor - Foot and Ankle Surgery
Washington University
St. Louis, MO

Washington University in St. Louis School of Medicine

Charcot Arthropathy

Patient Evaluation and Indications for Surgery

Jeremy J. McCormick, M.D.

My disclosures are listed in the AAOS database.

I have no potential conflicts with this presentation.

The life of a foot and ankle surgeon…

Glamourous

http://sportsillustrated.cnn.com/nhl/news/20130228/alex-steen-blues-concussion-injury.sp/

Not so glamourous…

http://www.pressenslidstens.com

Each equally important…

Charcot Arthropathy

Patient Evaluation and Indications for Surgery

- Overview on Charcot
- Staging and classification
- Approach to treatment

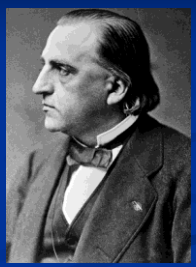
Charcot Arthropathy

Patient Evaluation and Indications for Surgery

- Overview on Charcot
- Staging and classification
- Approach to treatment

Jean-Martin Charcot

- French neurologist
- 1836 described unique arthropathy in patients with neurosyphilis



http://www.sciencemuseum.org.uk/broughttolife/people/jeanmartincharcot.aspx

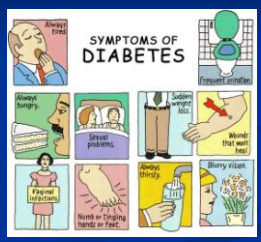
Definition

- Progressive, noninfectious, destructive arthropathy in patients with sensory neuropathy

Courtesy of Carroll P. Jones, MD

Who gets it?

- Linked with many diseases associated with peripheral neuropathy
- Described in diabetics in 1936 by William Reilly Jordan
- Diabetes is leading cause
  - Up to 40% will develop neuropathy in first decade of diabetes



http://www.healthisfuture.com/wp-content/uploads/symptoms-of-diabetes.jpg

It's not getting any better…

- 12.3% (28.9 million) of American adults >20y/o have diabetes
- 25.9% (11.2 million) of American adults >65y/o have diabetes
- By 2050, as many as 1 in 3 American adults will have diabetes

http://jaxrealestatefacts.com/2012/05/23/another-700k-houses-goes-under-contract-in-ortega/increasing-sales/

www.cdc.gov/diabetes/statistics

Why diabetes?

- Leads to neuropathy
  - Loss of nitric oxide function
    - Vasoconstriction/Ischemia
    - Injury to nerve cells/function
- Will not protect weightbearing
- Will not sense a problem

http://www.mynewtown.co.uk/newsviewer/tabid/1387/ArticleId/1013/Hot-footing-for-charity.aspx

Wukich and Kline – JBJS Am, 2008

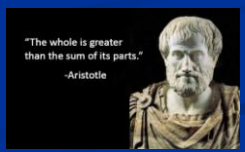
Etiology – Multiple Theories

- Neurotraumatic
  - Repetitive micro-trauma
- Neurovascular
  - Autonomic dysfunction that causes increases in blood flow
- Inflammatory mediated
  - Increase in cytokines >> osteoclastic activity
    - Baumhauer et al, 2006

http://www.everyvote.counts.org.uk/pack-content/politics-works/factsheets/political-parties.php

Likely a Combination of Events

- Peripheral neuropathy
- Unrecognized injury
- Repetitive stress on injured structures
- Increased local blood flow



http://www.sfmconsulting.co.uk/blog/entry/the_whole_is_greater_than_the_sum_of_its_parts

Charcot Arthropathy

Patient Evaluation and Indications for Surgery

- Overview on Charcot
- Staging and classification
- Approach to treatment

Eichenholtz Classification

- Radiographic natural history of changes that occur
- From destructive to consolidation
  - I – Fragmentation
  - II – Coalescence
  - III – Reconstruction
- A fourth stage (O) has been added

Eichenholtz SN (1966) General considerations. In: Eichenholtz SN (ed) Charcot joint. Thomas, Springfield, pp 3–20

http://edtreatmenttoday.com/ed-treatment-guide/steps-to-follow-in-ed-treatment/

Stage 0

- Swollen, red, warm foot
- Normal x-rays
- Different than infection
  - Elevation decreases swelling
  - No systemic symptoms

Courtesy of Carroll P. Jones, MD

Stage I - Fragmentation

- Swollen, warm, red foot
- Radiographs
  - Osteopenia
  - Fragmentation
  - Subluxation

Courtesy of Carroll P. Jones, MD

Stage II - Coalescence

- Clinical:
  - Decreased swelling
  - Decreased redness
  - Decreased warmth

Courtesy of Carroll P. Jones, MD

Stage II - Coalescence

- Radiographic:
  - Less bone debris
  - More sclerosis
  - Bone consolidation

Courtesy of Carroll P. Jones, MD

Stage III - Reconstruction

- Inflammation resolved
- Bone fully consolidated
- Generally more stable foot

Courtesy of Carroll P. Jones, MD

Anatomic Location of Charcot

- Sanders and Frykberg:
  - I: Forefoot (least common)
  - II: Midfoot (60%)
  - III: Hindfoot
  - IV: Ankle
  - V: Calcaneus

http://diabeticfootandankle.net/index.php/dfa/it/printerFriendly/21884/html

Charcot Arthropathy

Patient Evaluation and Indications for Surgery

- Overview on Charcot
- Staging and classification
- Approach to treatment

Goals of Treatment

- Reach Stage III with a stable plantigrade foot/ankle
- Prevent ulceration
- Avoid infection
- Ideally achieve these goals without surgery

http://blackeras.wordpress.com/about/

How should we approach this patient?

- Needs to be a team approach…
  - Orthopaedic surgeon
  - Medicine
  - Endocrine
  - Vascular
  - Orthotist/prosthetist
  - Physical therapist

http://dailystruggles-andupliftingscriptures.blogspot.com/2012/07

- Maintain high index of suspicion…

How should we approach this patient?

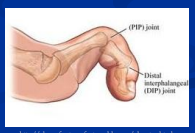
- History
  - Timing and mechanism
  - Is the patient aware of injury?
    - ? Neuropathy…
  - Systemic illness

- Understand the patient and possible risk factors…
  - HgbA1c, ulcers, vascular disease, renal failure, etc.

How should we approach this patient?

- Physical exam
  - Vascular
  - Motor
  - Sensory – neuropathy?
- Protective sensation?
  - Semmes-Weinstein monofilament
  - Associated with risk of Charcot
- Look for other signs
  - Claw toes
  - Ulcer/amputation

http://www.diabetesmdiacom/diabetes/4sc_4set_diabetes1.htm



http://shanesfootcomfort.weebly.com/claw-toe.html

The Challenge…

- Majority are morbidly obese
- Extreme difficulty complying with treatment
- Medical comorbidities
- Poor potential for healing
- Immunocompromised
- High risk of ulceration

http://visionaryfam.com/2014/02/time-for-a-challenge/

Stage I – Non-op Treatment

- Total Contact Cast
- Immobilization is critical
- Minimize deformity
- Control swelling
- Offload foot
- 2-3 months if possible
- Follow closely

http://www.o-wm.com/content/total-contact-cast-system-simplifies-application-process

Can You Keep Them NWB?

- Very difficult
- Probably only 50% compliance
- Even if WB may still achieve good result
  - De Souza, et al – JBJS, 2008
- Err on the side of casting for too long…

http://www.confusereviews.com/?p=3729

Stages II – Non-op Treatment

- Charcot Restraint Orthotic Walker (CROW)
- Other AFO

http://www.mecleveop.com/orthotics/crow-boots/

http://lermagazine.com/article/evidence-based-orthotic-management-of-ptfd

Stages III – Non-op Treatment

- In-depth shoe
  - Custom insert
- Life long
- Educate the patient

http://www.valentineorthotics.com/medicare-shoe-program.html

Non-op is NOT Easy!

- 23% required bracing > 18 months
- 49% risk of recurrent ulceration
- Ulceration increases risk of amputation
- 2.7% annual rate of amputation

Saltzman – CORR, 2005

http://wwwthegodboxproject.com/blog/2012/03/16/fun-friday-the-secret-to-saying-no/fingers-crossed-2/

Surgical Indications

- Unstable, unbraceable deformity
- Recurrent ulceration
- Deep infection
- Deformity at high-risk for ulceration

http://wwwidlehearts.com/if-plan-a-didnt-work/559/

Charcot Arthropathy

Patient Evaluation and Indications for Surgery

- Overview on Charcot
- Staging and classification
- Approach to treatment

Take Home Points

- Understand the natural progression of Charcot
- Early recognition and treatment
  - Maintain a high index of suspicion
- Achieve early stability and maintain alignment through casting

Thank you…

Washington University in St. Louis
School of Medicine

Charcot Arthropathy: Internal Fixation

VuMedi Webinar July 2014
Carroll P. Jones MD
OrthoCarolina Foot and Ankle Institute
Charlotte, NC

Disclosures: AAOS Website.

Paid consultant for Wright Medical Technology and have been involved in the development of Charcot-specific implants.

Goals of Treatment

- **Reach consolidation phase with a stable plantigrade foot/ankle**
- **Prevent ulceration/infection**
- **Ideally achieve these goals nonoperatively**

- **Nonop treatment 70% successful**
  - Clinically plantigrade foot
  - Radiographically plantigrade
    - Pinzur et al; FAI 1993
    - Fabrin et al; Diabetes Care 2000
    - Pinzur et al; FAI 2004

Surgical Indications

- Unstable, unbraceable deformity
- Recurrent ulceration
- Deep infection
- Deformity at high-risk for ulceration

Clinical Challenge

- Limited Level-I evidence
- Effective clinical algorithm
  - Nonop (total contact cast)
  - Exostectomy
  - Surgical correction: internal fixation
  - Surgical correction: external fixation

Algorithm

- Plantigrade
  - Total Contact Cast/Brace
- Nonplantigrade
  - Low Risk
    - Corrective osteotomy: Internal Fixation
  - High Risk
    - Thin-wire Fixation

Ankle/Hindfoot Charcot

- Arthrodesis provides the most reliable and durable correction and stability
- Most deformities can be corrected intraoperatively
- Typically include both ankle and ST joints for levels of fixation
- Internal fixation reserved for relatively “clean” cases

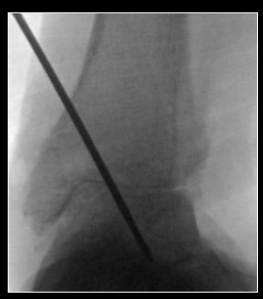
Case Example

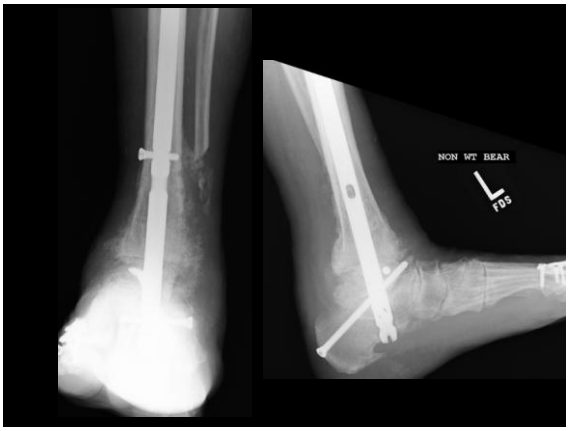
- 70 yo diabetic neuropathy
- 4 month h/o ankle deformity
- Unable to ambulate

Transfibular Approach

Joint Preparation

Reduced Mortise



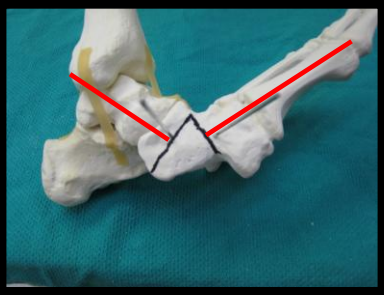


TTC Intramedullary Rod

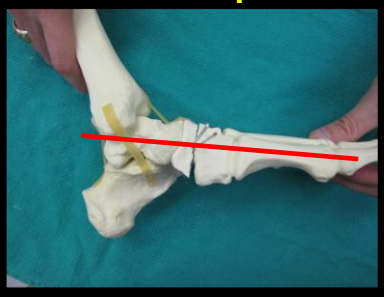
- Load-sharing device (vs plate/screw fixation)
- Bridge ankle and ST joints
- Percutaneous insertion
- Soft-tissue friendly
- Low metal/hardware exposure (intraosseous)
- Frame can be added if necessary

Midfoot Charcot

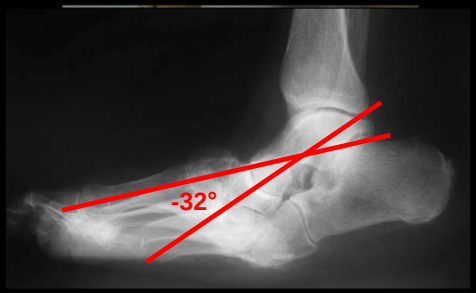
Technique



Technique



Low Risk Charcot

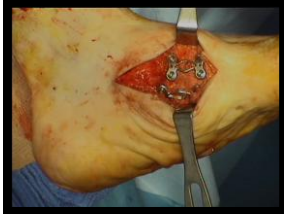


Surgical Approach

Surgical Approach

Video

Internal Fixation



How Much Fixation?

Charcot-Indicated Plates

What About Beaming?

- Relatively new technique for Charcot (1997?)
- Similar to rebar in construction
- Concrete has very poor tensile properties
- Rebar + concrete: magnitudes stronger

What is Beaming?

- Intraosseous fixation bridging one or multiple joints
- Screw, rod , or bolt
- Most commonly used in the medial column

62 yo Recurrent Ulceration

62 yo Recurrent Ulceration

6 Months Postop

My Technique

- Evolving…
- 6.5 mm solid bolt stainless steel system
- Retrograde 1st ray/talus bolt
- Retrograde lateral column bolt
- Rarely augment with plate fixation

55 yo Painful Charcot

9 Months Postop

Caveats

- TAL critical
- Prepare all joints that the bolts cross
- Bone graft defects (typically allograft)
- NWB in TCC for 8-10 weeks
- Transition to extra-depth shoe/insert

Results

Charlotte experience

- 6 patients
- Minimum 6 month f/u
- All clinically/radiographically healed
- No deep infections
- One required plantar lateral exostectomy 4 months postop

Conclusions

- Consider internal fixation for unstable ankle and mid/hindfoot Charcot in absence of deep infection
- Adjunctive external fixation should be considered
- Beaming very promising for midfoot – need for greater variety of sizes

Thank You!

Charcot Foot Treated with a Static Circular External Fixator

Michael S. Pinzur, MD
Professor of Orthopaedic Surgery
Loyola University health System

Disclosure

Consultant
- Small Bone Innovations
- Wright Medical

Lecturer
- Smith-Nephew
- Stryker

Favorable Outcome

Ulcer and Infection-Free

Able to ambulate independently with
- commercially-available therapeutic shoes
- custom accommodative foot orthoses

Who needs surgery?

1. Non-plantigrade foot with overlying ulcer and osteomyelitis
2. Clinically and radiographically non-plantigrade foot
3. Painful neuropathic *non-union*

Principles of Static Ring

Able to **OBTAIN** correction of deformity

Obstacles to **MAINTAIN** correction:

- vitamin D deficient / poor quality bone
- poor host

Motor Balancing

Gastrocnemius muscle lengthening

or

Tendon Achilles lengthening


LOYOLA
UNIVERSITY
HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH

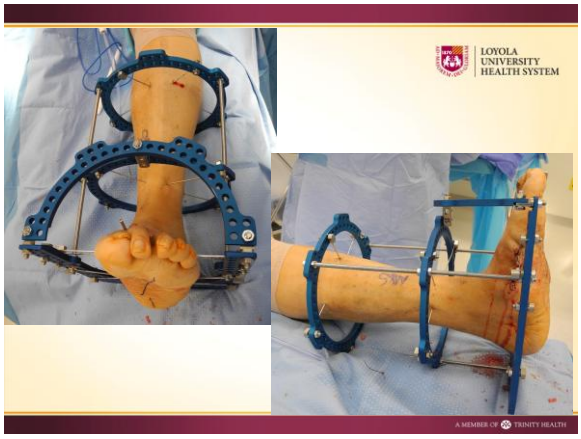

LOYOLA
UNIVERSITY
HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH


LOYOLA
UNIVERSITY
HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH


A MEMBER OF TRINITY HEALTH


LOYOLA
UNIVERSITY
HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH


LOYOLA
UNIVERSITY
HEALTH SYSTEM


LOYOLA UNIVERSITY HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH


LOYOLA UNIVERSITY HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH


LOYOLA UNIVERSITY HEALTH SYSTEM


LOYOLA
UNIVERSITY
HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH


LOYOLA
UNIVERSITY
HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH


LOYOLA
UNIVERSITY
HEALTH SYSTEM
A MEMBER OF TRINITY HEALTH

LOYOLA UNIVERSITY HEALTH SYSTEM

- Static Ring Fixation
- Obtain correction at surgery
- Difficulty with maintaining correction

A MEMBER OF TRINITY HEALTH

Richard Gellman, MD
Summit Orthopaedics
Portland, OR

Dynamic External Fixation in Charcot Reconstruction

Definition

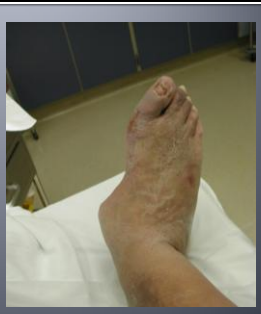
- Dynamic = gradual deformity correction using Ilizarov multiplanar external fixation
- Most corrections with Taylor Spatial Struts
  - Simple lengthenings or distraction with threaded rods
  - Some ankle equinus corrections in lighter patients with universal hinges

Goal

- Create a stable, plantigrade, ulcer-free foot below an aligned leg

Patient Indication

- Unbraceable, unstable deformity
- ± Recurrent ulceration
- Non ambulatory patients wanting alternative to amputation
- Patients need to understand that this is limb salvage surgery. Risk of amputation or need for future reconstructions 20%



Patient Selection

- Deformities that can't be acutely corrected
  - Too severe
    - plantigrade foot not obtainable despite heroic attempts at soft tissue release, bone shortening,
  - Poor soft tissue, unsafe to make requisite surgical dissections
  - Acute correction would lead to unwanted arthrodesis such as a pantalar or TCC

Advantages

- Safe to operate on contracted or previously operated soft tissue
- Maintains bone length, may limit need for arthrodesis
- Lower deep infection rate
- Ability to allow limited weight bearing due to strength of frames

Surgical Experience

- Best to have applied quite a few static Holding Frames before attempting dynamic frames

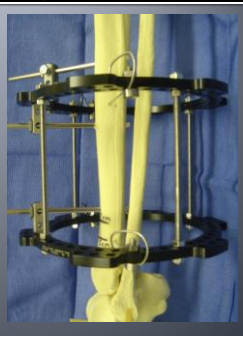
Deformity Types

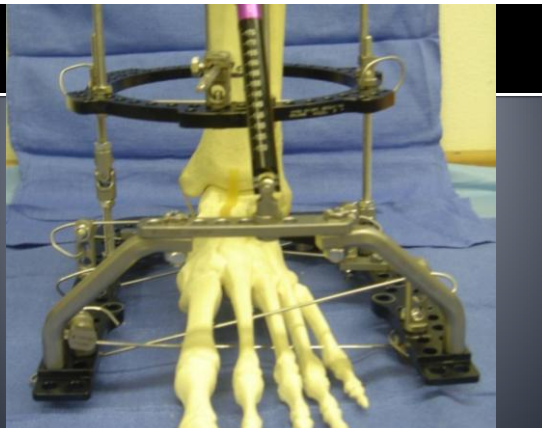
- Ankle
- Combined Foot Deformity = hindfoot and midfoot deformities
- Midfoot

Ankle Deformity

- Examples: ankle equinus contracture, neuropathic ankle fx/dx, AVN talus, distal tibia collapse
- Apply standard 2 ring tibial base frame, one long foot ring and connect lower tibial ring to foot ring with Taylor Spatial struts
- If deformity at tibiotalar joint, insert a talar neck wire and attach to foot ring. This focuses distraction, correction across ankle joint

Tibia Base Frame





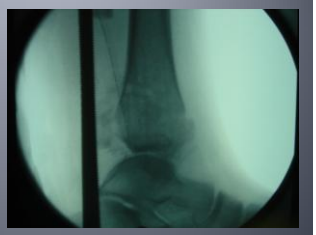
Ankle Equinus

- Always perform percutaneous achilles lengthening or tenotomy first in equinus corrections
- Set up TSF program as apex anterior deformity with origin at center of talar dome
- Hold in corrected position of at least 10 degrees dorsiflexion for 6 weeks to prevent recurrence

Ankle Deformity/multiplanar

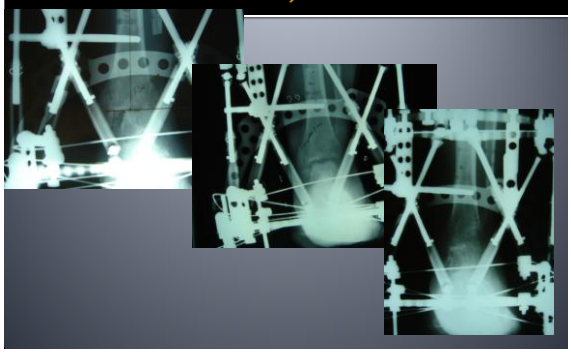
- Ideal for contracted longstanding ankle/hindfoot dislocations
- For a more rapid correction, especially with infected cases, I perform talectomy, antibiotic bead placement, deformity correction
- Stage Tibia-Calcaneal fusion in 4-6 weeks
- Frames can be set up to allow insertion of 16 cm hindfoot fusion nails

Neuropathic Ankle Fx/Dx

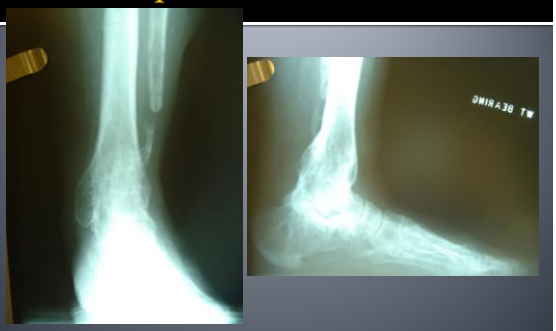


Stage 1: Infection control

Stage 2: Arthrodesis (gradual correction)



Follow-up

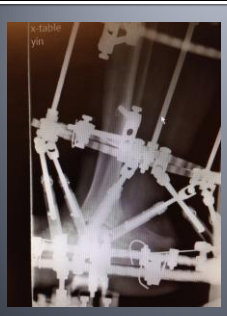


Ankle Deformity/multiplanar

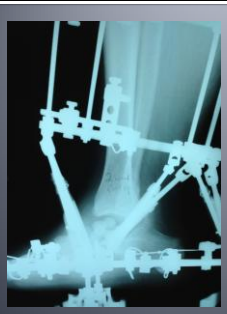
- 59 yom DM
- Morbid obesity
- Longstanding lateral peritalar dislocation (PTTD gone wild)
- Active MSSA infection over ulcer breakdown on talar head, I&D site by his podiatrist
- Not able to walk

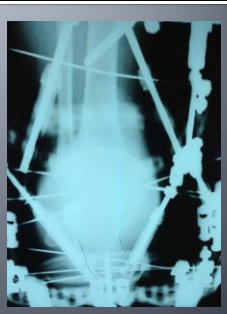
Deformity: short, laterally translated

Step 1: talectomy, abx beads, TSF

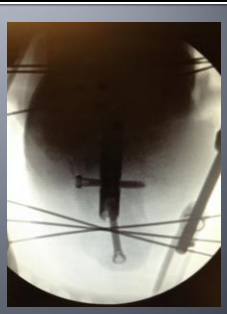


Step 2: deformity correction, 2wks post op

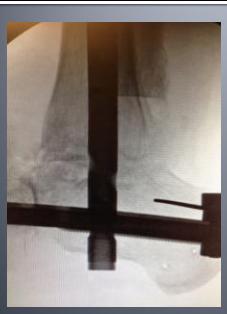
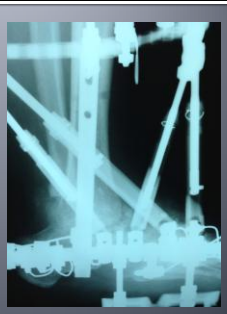




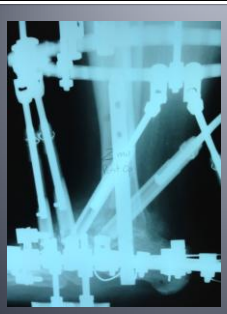
Step 3: staged tib-cal arthrodesis

Hindfoot fusion nail; conversion to holding frame

2 mo. post fusion, 4 mo. total time in frame




Stable at one year


Combined Foot Deformity

- Severe valgus peritalar dislocation, rigid equinovarus foot
- Hindfoot and midfoot both in varus or valgus
- Set up like Ankle equinus frame except talar neck wire attaches to distal tibia by long hinges. This stabilizes the ankle joint (talus in the mortise) so that correction occurs through the subtalar, talonavicular, calcaneal-cuboid joint complex

Combined Foot Deformity

- Forefoot deformity of aDduction or aBduction can be acutely corrected with "drag" olive wires
- May need to pin toes
- In severe deformities, may need to prevent weight bearing for first 1-2 weeks until the sole of the foot is more plantigrade

Rigid Equinovarus (not Charcot)

Midfoot Deformity

- Apply tibial base frame
- Place U-ring along posterior aspect of distal tibia on lateral view
- Attach full ring that encircles the forefoot
- Place at least 3 wires into metatarsals for sufficient strength of fixation
- Attach struts after insertion of first forefoot wire to make strut attachment easier

"Butt Plate" set up

Midfoot Deformity

- May need to first distract (lengthen) 10-15 mm in order to disengage midfoot bones prior to correction of angular or translational deformity
- TSF software pretty good for midfoot correction
- Option to set up as tibia but have forefoot correlate to proximal tibia

Midfoot Deformity and Ankle Equinus

- 57 yom with DM.
- Chronic midfoot ulceration over 10 years
- Failed debridements and CROW
- MR negative for deep bone involvement
- Teaches nursing at local college

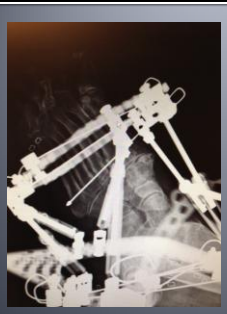
Deformity

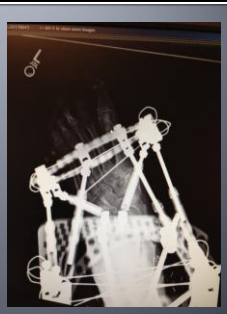
- 40 degrees Talo-1st Met
- No significant hindfoot malalignment

Step 1: Debridement & TSF

- Debridement and closure of ulcer
- Gradual correction of midfoot rocker bottom and abduction contracture with frame
- Safer for lateral skin

Step 2: Gradual correction over 2 wks

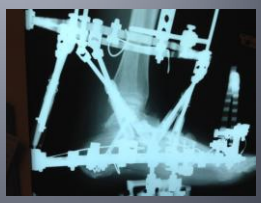




Step 3: fusion & equinus correction

- 3 weeks after frame application
- Staged triple and 1st TMT arthrodesis
- Frame modification to correct equinus contracture

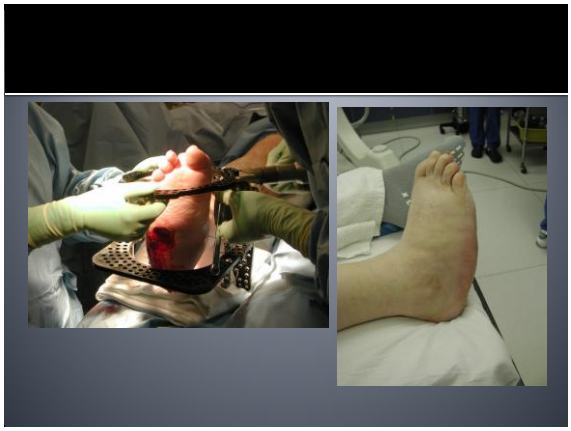
Equinus correction

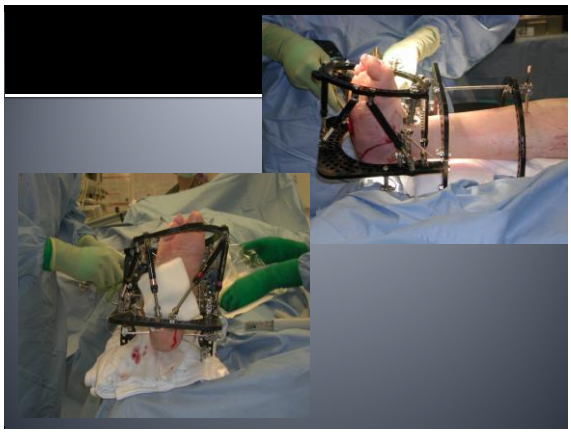


7 wks post frame removal

Plantigrade, ulcer healed

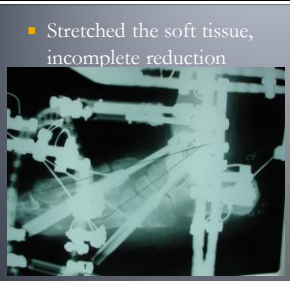
Acute Charcot, active ulcer





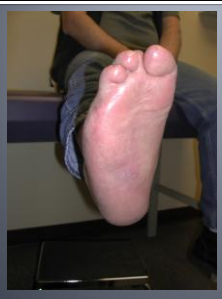
Note Drag Wires

- Stretched the soft tissue, incomplete reduction



Staged Arthrodesis


Healed despite deep infection




Late triple arthrodesis


Common Pitfalls

- Lack of experience with static frames prior to attempting dynamic frames
- Challenges of placing sufficient number of wires to create a stable and strong frame in small areas of the foot
- Challenge of working around struts
- Experience in running TSF programs
- Experience in applying frames in a manner to allow strut application and decrease strut changes

Common Pitfalls

- Keeping wire fixation away from osteotomies and internal fixation
- Aggressively managing pin site infections
- Planning frame modifications in the OR to replace broken or loose wires before catastrophic failure occurs
- Need to perform staged arthrodesis to maintain correction
- Gradual transitions after frames are removed with walking casts and AFOs

gellman@summitdocs.com

Good Luck!!!!!