Charcot Neuroarthropathy

ETIOLOGY

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SEPTEMBER 2018

Disclaimer

- ✓ No relevant financial relationships
- ✓ No conflicts of interest to disclose

Objectives

- Summarize and understand basic pathophysiology behind Charcot Neuroarthropathy (CN)

Definition

- Progressive, noninfectious, destructive inflammatory process of the foot and ankle (1)
- Jean-Martin Charcot
  - French Neurologist
  - Dr. Elliott has uncovered literature to dispute the original description
- Tabes Dorsalis (Tertiary syphilis)
- Long-standing diabetes (1)

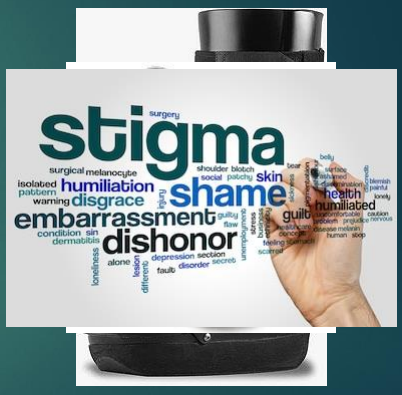
Diabetes

- CDC 2017 Report:
  - 30.3 million Americans have diabetes **(9.4%)**
  - 70 million Americans are prediabetic

Advances in modern medical treatments → Prolonged lifespan → Diabetic-associated complications ↑

Negative Impacts of CN

- Physical disability/limitations
- Financial burden
  - Individual
  - Health Care System
- Social stigma



Etiology

- Peripheral Neuropathy (PN)
  - Absence of protective sensation

Causes of PN

- **Diabetes**
- **Alcoholism**
- Dietary (Vitamin deficiencies)
  - Especially B1, B6, B12, E
- Infectious
  - Viral or Bacterial
  - Lyme disease, shingles, Epstein-Barr virus, hepatitis C, leprosy, syphilis, diphtheria, HIV
- Autoimmune
  - Sjogren's syndrome, lupus, rheumatoid arthritis, Guillain-Barre syndrome, chronic inflammatory demyelinating polyneuropathy, necrotizing vasculitis
- Hereditary
  - Charcot-Marie-Tooth disease
- Trauma
  - Motor vehicle accidents, falls or sports injuries
  - Iatrogenic (casts, OR positioning)
- Tumors
  - Benign or malignant
  - Can directly involve nerves or place pressure on nerves
- Other
  - Kidney disease, liver disease, connective tissue disorders and an underactive thyroid (hypothyroidism)
- Idiopathic

How does Diabetes cause PN?

- Selectively damages cells whose glucose transport rate does not rapidly decline in response to hyperglycemia, leading to high glucose levels inside the cell (2)
  - Activates four major pathways
    - Polyol, Hexosamine, Protein Kinase C, Advanced Glycation End products (AGE)
    - Inhibits a key glycolytic enzyme
      - Glyceraldehyde-3 phosphate dehydrogenase (GAPDH)

Two Explanations for CN

- **Neurotraumatic**
  - Trauma in context of PN
    - Acute, subacute, cumulative/repetitive
    - Traumatic event activates a cascade of proinflammatory cytokines, TNF-a, interleukin-1β, interleukin-6 (3-5)
      - TNF-a upregulates the receptor activator of nuclear factor-κB (RANK) ligand, i.e. RANKL system
        - Intense osteoclast activity = excessive bone turnover
    - Decreased anti-inflammatory cytokines and antagonist to RANKL system – osteoprotegerin (3-5)
    - Bone breakdown ensues without regulation, leading to a collapse of the foot structure

Two Explanations for CN

- **Neurovascular**
  - Originally described by Jean-Martin Charcot (French Neurologist) in 1883
    - Hyperemia develops from overactive vaso-autonomic neuropathy (6)
    - Increased blood flow raises venous pressure and enhances fluid filtration through capillary leakage → Increased compartmental pressure and deep tissue ischemia → compromises tendons and ligaments in the foot & ankle → joint instability → collapse (7)
    - Additionally, increased blood flow causes increased delivery of osteoclasts and monocytes resulting in greater bone resorption (8)
  - Patients with Charcot Foot demonstrate increased blood flow (macro) to the foot/ankle; patients with peripheral arterial disease (PAD) rarely develop Charcot neuroarthropathy (9-10)

Combination Theory

- CN is likely caused by a combination of both theories
- Continued weight-bearing without sufficient protection (guarding, offloading, activity restriction) leads to repetitive microtrauma and perpetuates increased proinflammatory cytokines, magnifying the intensity of a Charcot event, preventing proper bone remodeling and eventual loss of structural integrity of the bones & joints of the foot (i.e. fracture, subluxation/dislocation)

Charcot Foot

Ultimately…

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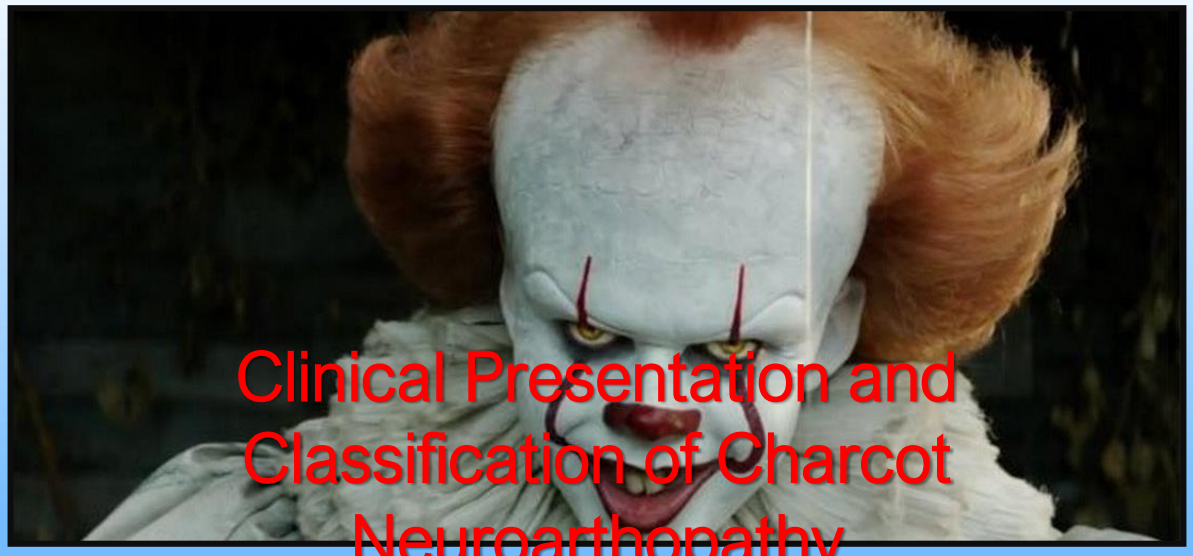

Clinical Presentation and Classification of Charcot Neuroarthopathy

Andrew D. Elliott, DPM, JD
September 2018

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Charcot Neuroarthropathy:

Seen in patients with the following conditions:
Alcoholism
Leprosy

Type I
Presents in the 50th decade (40s)
20-24yr ave duration with the disease

Type II
Presents in the 60th decade (50s)
5-9yr ave duration with the disease

Petrova NL, et al. Difference in presentation of Charot osteoarthropathy in type 1 compared to type 2 diabetes. Diabetes Care 2004;27:1235-1236.

CN within d
Incidence
Prevalenc
29% of dia
with CN
80% of ca
Mean age of onset: 50.3yrs
Men = Women
5yr mortality: 28.3%

La Fontaine J, et al. Current Concepts of the Charcot Foot in Diabetic Patients. The Foot 26(2016) 7-14.

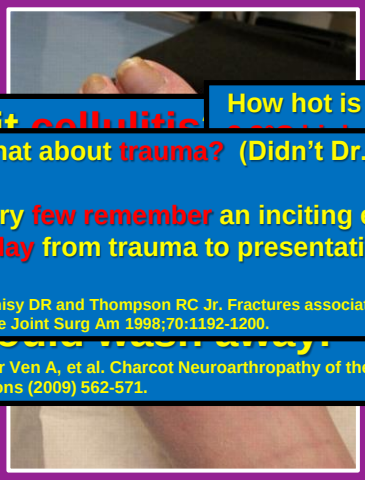
thy (CN):
English physician,
o a venereal disease
French Neurologist
arthopathy in the foot
lis (from neurosyphylis)
condition described in diabetics

Yes, but what does CN look like?

- Acute CN can look like lots of things…

- Gout
- Cellulitis/osteomyelitis
- Trauma
- Stress Fractures
- Deep Vein Thrombosis

Clinical Picture of Acute CN



How hot is hot?

What about trauma? (Didn't Dr. Simonson say something about that?)

Very few remember an inciting event but of those that did there was a 5 week delay from trauma to presentation.

Clohisy DR and Thompson RC Jr. Fractures associated with neuropathic arthropathy in adults who have juvenile-onset diabetes. J Bone Joint Surg Am 1998;70:1192-1200.

Surgery of the Foot and Ankle, ed 8. St. Louis, MO, Mosby, 2006, pp 1281-1368.

van der Ven A, et al. Charcot Neuroarthropathy of the Foot and Ankle. Journal of the American Academy of Orthopaedic Surgeons (2009) 562-571.

Clinical Picture of Chronic CN

le or Unstable deformities
uxation or dislocation at
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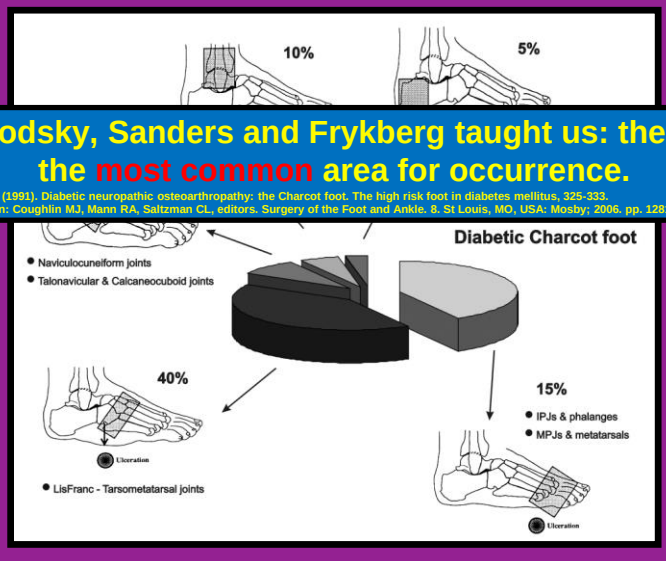
cker Bottom" foot

Where does CN occur?



As Drs. Brodsky, Sanders and Frykberg taught us: the midfoot is the most common area for occurrence.

Sanders, L. J., & Frykberg, R. G. (1991). Diabetic neuropathic osteoarthropathy: the Charcot foot. The high risk foot in diabetes mellitus, 325-333.
Brodsky JW. The diabetic foot. In: Coughlin MJ, Mann RA, Saltzman CL, editors. Surgery of the Foot and Ankle. 8. St Louis, MO, USA: Mosby; 2006. pp. 1281–1368.

How to Classify CN?

Brodsky's anatomic classification system can be useful to discuss treatment option; however, it doesn't include any staging.

Brodsky JW. The diabetic foot. In: Coughlin MJ, Mann RA,Saltzman CL, eds. Surgery of the Foot and Ankle. 8th ed. St. Louis, MO, USA: Mosby; 2006:1281–1368.

Type	Location	Involved joints
1	Midfoot	Tarsometatarsal, naviculocuneiform
2	Hindfoot	Subtalar, talonavicular, calcaneocuboid
3A	Ankle	Tibiotalar
3B	Calcaneus	Tuberosity fracture
4	Multiple regions	Sequential, concurrent
5	Forefoot	Metatarsophalangeal

However…

Stage	Radiographic findings	Clinical findings	Treatment
0 (prodromal)	Normal radiographs	Swelling, erythema, warmth	Patient education, serial radiographs to
			orthotic walker, or clamshell ankle-foot orthosis
III (reconstruction)	Consolidation of deformity, joint arthrosis, fibrous ankyloses, rounding and smoothing of bone fragments	Absence of warmth, absence of swelling, absence of erythema, stable joint ± fixed deformity	Plantigrade foot: custom inlay shoes with rigid shank and rocker bottom sole. Nonplantigrade foot or ulceration: débridement, exostectomy, deformity correction, or fusion with internal fixation.

Because it ignores the most clinically relevant stage, in 1990, Shibata et al. proposed a stage 0 based primarily on clinical and scintigraphic signs without obvious radiographic findings.

Shibata T, Tada K, Hashizume C. The results of arthrodesis of the ankle for leprotic neuroarthropathy. J Bone Joint Surg Am. 1990;72:749–756.

Lets try MRI…

Chantelau … iation and durati…

Immediate … s the inflammati… full blown arth…

Chantelau EA, Richter A.

Stage	Grade 0 (low severity)	Grade 1 (high severity)	
Active (acute)	Mild edema, erythema, and warmth	Severe edema, erythema, and warmth	Clinical
	Possible pain	Possible pain	
	No deformity	Gross deformity	
	No osseous abnormality	Macrofractures	Radiographs
	MRI – bone marrow edema, microfractures, no cortical disruption	MRI – bone marrow edema, macrofractures, cortical disruption	MRI
	Lamellar bone with active surface	Increased marrow space vascularity	Histopathology
	Trabeculae remodeling associated with microfracture	Active remodeling of woven bone	
	Marrow space replaced by loose spindle cells	Osteonecrosis	
		Invasion of inflammatory cells	
		Thickened synovium	
		Fragmented cartilage and subchondral bone	
Inactive (chronic)	No inflammation	No inflammation	Clinical
	No deformity	Gross deformity	
	No osseous abnormality	Osseous abnormality	Radiographs
	MRI – no significant bone marrow edema	MRI – no significant bone marrow edema	MRI
	Sclerosis of bone, broad lamellar trabeculae with collagenous replacement; low vascularity of the marrow space	Woven bone, immature and structurally disorganized, fibrosis	Histopathology

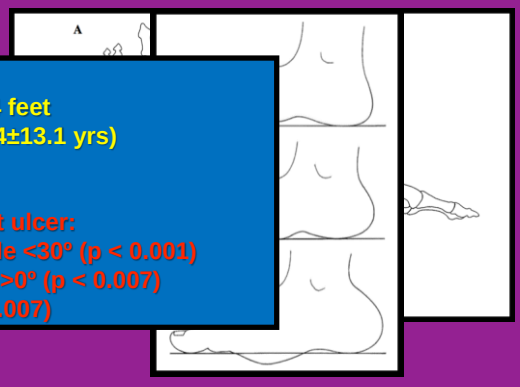
Schon Midfoot Classification

Severity of Deformity based on lateral X-ra

A: Mild:
the plan
B: Mode
level of t
C: Sever
the level of the plantar foot (Rocker Bottom)

Schon LC, Easley ME, Weinfeld SB. Charcot neuroarthropathy of the foot and ankle. Clin Orthop Relat Res. Apr 1998(349):116-131.

2008 study by Wesley et al.
- **Restrostpective review involving 24 feet**
  - **10 men 14 women (mean age 54±13.1 yrs)**
  - **9 ulcers and 2 pre-ulcers**
  - **14 feet Schon β**
- **Significant correlation with mid foot ulcer:**
  - **Lateral talar 1st metatarsal angle <30° (p < 0.001)**
  - **Calcaneal 5th metatarsal angle >0° (p < 0.007)**
  - **Feet classified as Severe (p < 0.007)**



Medial Column Classification

Sella and Barrette's system is based on xrays, clinical findings and bone scans:
Stage 0 Localized heat and swelling; xray normal
Stage 1 Stage early bone involvement on radiographs
Stage 2 Joint subluxation
Stage 3 Joint dislocation and collapse
Stage 4 healing and sclerosis

Sella EJ, Barrette C. Staging of Charcot neuroarthropathy along the medial column of the foot in the diabetic patient. J Foot Ankle Surg. Jan-Feb 1999;38(1):34-40.

Stage	Diagnosis
0	Localized heat and midfoot swelling
1	Localized osteoporosis, subchondral cysts, erosions, and diastasis
2	Joint subluxations
3	Joint dislocations
4	Sclerosis and ultimate fusion of involved joint

Stage	No. of Feet	Radiographs	Scans – Tc99	Scan-In/Ga	Clinical Findings
0	10	Negative	+	-	Increased heat
1	6	Cysts, erosions, diastasis	+	-	Increased heat and swelling
2	16	Joint subluxation	+	-/less +	Mild pronation
3	12	Joint dislocation	+	-/less +	Bony prominences, pronation, rocker bottom
4	7	Joint Fusions and Sclerosis	-	-	Rocker bottom, bony prominences, pronation

Predicative of outcomes?

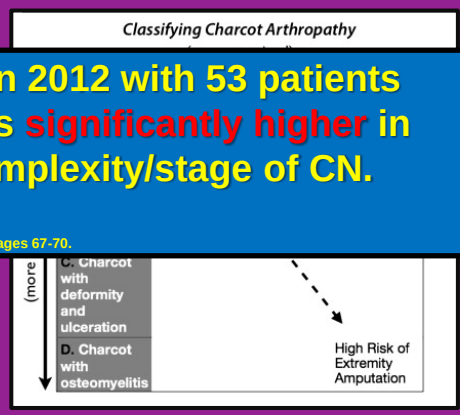
Rogers and Bevilacqua considered

guess.

Rogers L, Bevilacqua N. The Diagnosis of Charcot Foot. Clin Podiatr Med Surg. 2008;25:43–51

Likely accurate as it was shown in 2012 with 53 patients showing the risk of amputation was significantly higher in association with location and complexity/stage of CN.

Visvanathan V et al. The Journal of Diabetic Foot Complications, 2012; Volume 4, Issue 3, No. 2, Pages 67-70.



In Conclusion

-If you have a red, hot swollen foot in a long standing diabetic no obvious explination, get an MRI

-Eichenholtz is still a fairly common staging system

-Other newer staging systems are also in use that provide better, more predictive information

THANK YOU

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Charcot Neuroarthropathy

IMAGING

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SEPTEMBER 2018

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Objectives

- Summarize and understand imaging considerations for Charcot Neuroarthropathy (CN)

Diagnosis

- Diagnosis of CN is primarily clinical (1-3)
- A clinical suspicion for acute CN should be followed by ordering appropriate diagnostic imaging
- Provides details to establish a definitive diagnosis and guide treatment

Venous Duplex Ultrasonography

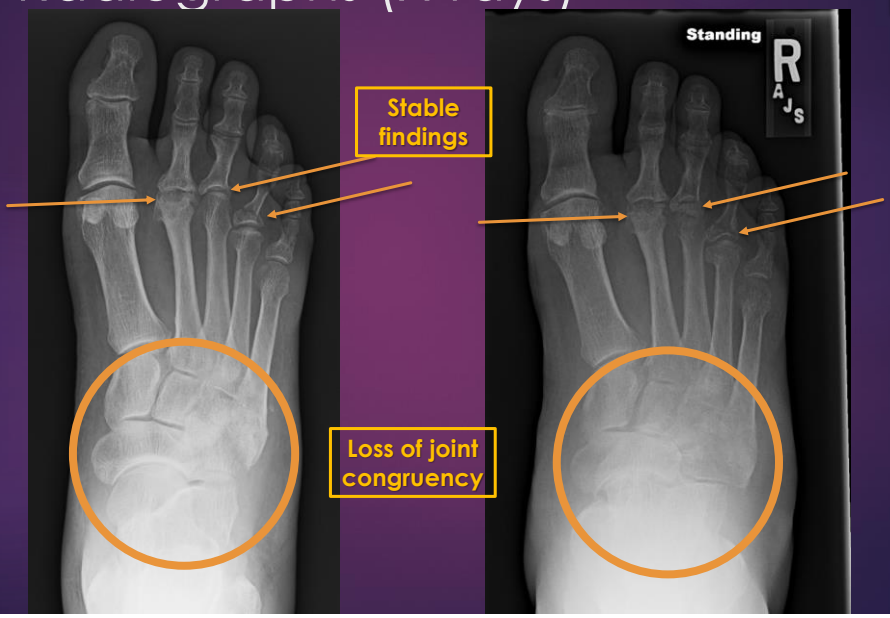
- Performed when deep vein thrombosis (DVT) is suspected
- Results should be normal in acute CN (4)
- DVT
  - Unilateral edema, erythema, calor and pain

Plain Radiographs (X-rays)

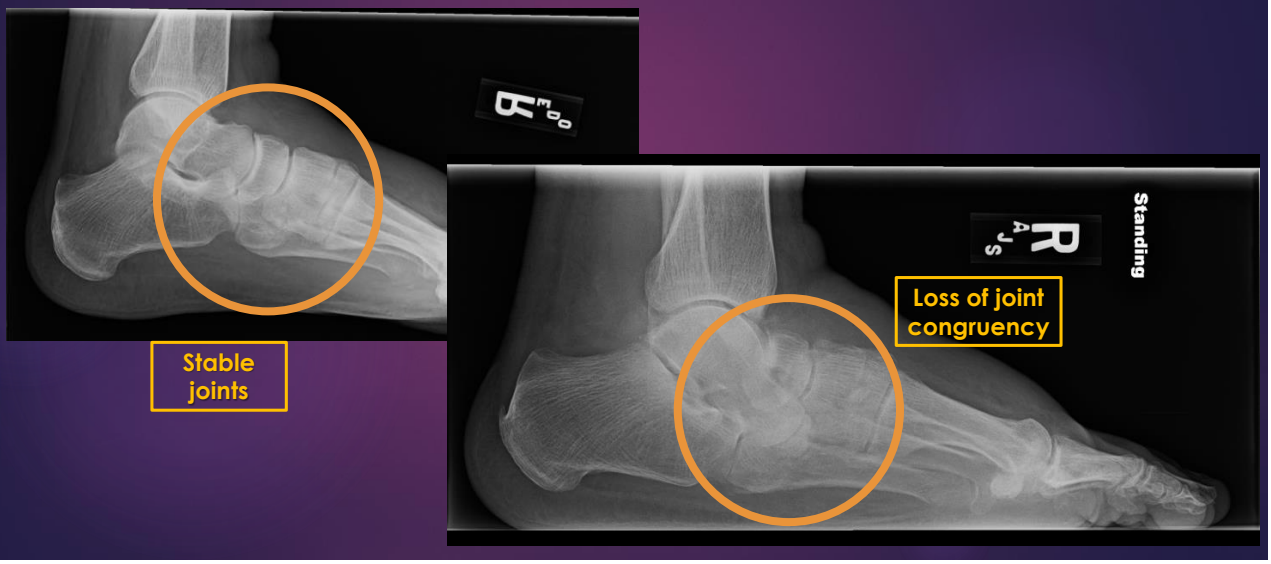
- Initial imaging of choice
- Weightbearing (WB)
  - Unless patient is not able to stand
  - Better assess for subtle joint abnormalities
- Bilateral feet
  - Unless patient only has one foot
  - Allows comparison with unaffected side
- Accuracy of differentiating osteomyelitis from Charcot is only about 50-60% (1)
- Findings may be absent/negative within first 2-3 weeks of acute event (1,2) or even longer (4)

Plain Radiographs (X-rays)

Plain Radiographs (X-rays)



Plain Radiographs (X-rays)



Plain Radiographs (X-rays)

Plain Radiographs (X-rays)

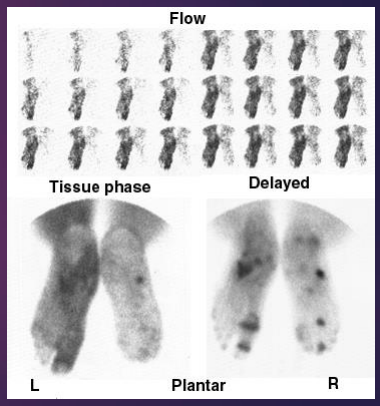
- Findings most accurate:
  - Demineralization
  - Periosteal reaction
  - Cortical destruction
- Useful in ruling out other pathology (fractures, arthritis, etc.)
- Serve as a baseline for future studies, especially in at risk patients

Computed tomography (CT)

- More sensitive than plain film radiographs
- With contrast, can aid in detecting abscess formation
- Cannot determine early bone morrow edema or microfractures
  - Found in the acute phase of CN
  - Therefore is not recommended for diagnosis (2,3)

Nuclear Imaging

- Well established for detecting bone infections
- Can seem complicated if you don't order these scans with regularity
- 3-phase bone scintigraphy (1)
  - Highly sensitive for osteomyelitis (80-100%)
  - Not specific
  - Trauma, arthritis, recent surgery or CN will result in high uptake
  - Negative bone scan excludes only infection



Nuclear Imaging

- Labeled leukocyte scans have better specificity than 3-phase alone (1-3)
  - ^{99}Technetium methylene diphosphonate (^{99}Tc MDP) labels hydroxyapatite, which is used to measure bone turnover
    - Bone turnover is high in Charcot, trauma and infection, so this scan alone cannot differentiate between Charcot and infection

Nuclear Imaging

- Labeled leukocyte scans have better specificity than 3-phase alone (1-3)
  - ^{111}Indium labeled leukocytes localize in neutrophil-mediated inflammatory processes, such as bacterial infections in bone – **should not appear in the absence of infection** (1-3)
  - ^{99}Tc MDP & ^{111}Indium in combination for the diagnosis of osteomyelitis (1)
    - 50% sensitive
    - 100% specific
    - 81% accurate

Nuclear Imaging

- Labeled leukocyte scans have better specificity than 3-phase alone (1-3)
  - ^{99}Tc sulfa colloid scans image areas of reticuloendothelial cells, found in the liver, spleen and **bone marrow**
    - Known as "bone marrow imaging"
    - No uptake in areas of bone infection
  - Using ^{99}Tc sulfa colloid & ^{111}Indium together can improve the accuracy in differentiating between infection and inflammation seen in acute Charcot (1-3)

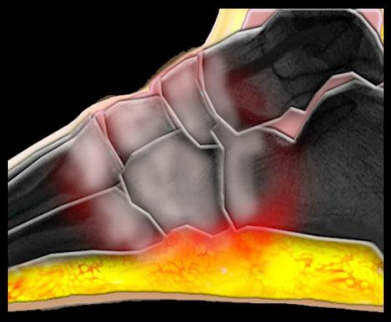
Magnetic resonance imaging (MRI)

- Generally supported as superior to nuclear imaging tests in aiding diagnosis (1)
- Can effectively detect soft tissue edema, joint effusion and bone marrow changes in the early/acute phase
  - Detects abnormalities earlier than plain film radiographs

Magnetic resonance imaging (MRI)

- Helpful in ruling out abscess, sinus tracts and osteomyelitis
  - Osteomyelitis - focal involvement of a single bone or joint
  - Charcot arthropathy - involves several joints/bones (1,5)
- More sensitive, but less specific than combined ^{99}Tc SC & ^{111}Indium bone scan (2)
- Limitations
  - Recent surgery
  - Retained hardware
  - Pacemaker, aneurysm clips or renal insufficiency preventing IV contrast

Magr

Osteomyelitis	Active Charcot
	
Hot red foot with ulcer Forefoot: MTP's IP's Hindfoot: calcaneus ***X-ray*** normal first weeks ***MRI*** marrow edema in forefoot and hindfoot near ulcer	Hot red foot - no ulcer Midfoot subarticular ***X-ray*** normal first weeks ***MRI*** marrow edema in midfoot subchondral

PET Scans

- Shows promise in differentiating CN from infection, but these techniques are not widely available, and clinical usefulness is yet to be determined (1,3)

Take Home Points

- X-rays are a MUST, but may not be enough
- Don't use CT imaging
- If using bone scan/nuclear imaging, use combination of ^{99}Tc sulfa colloid & ^{111}Indium
- **MRI with contrast is your best bet, unless CN & infection both present**
- PET Scans?

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2. Trepman E, Nihal A, Pinzur MS. Current Topics Review: Charcot Neuroarthropathy of the Foot and Ankle. *Foot Ankle Int.* 2005;26(1):46-63.
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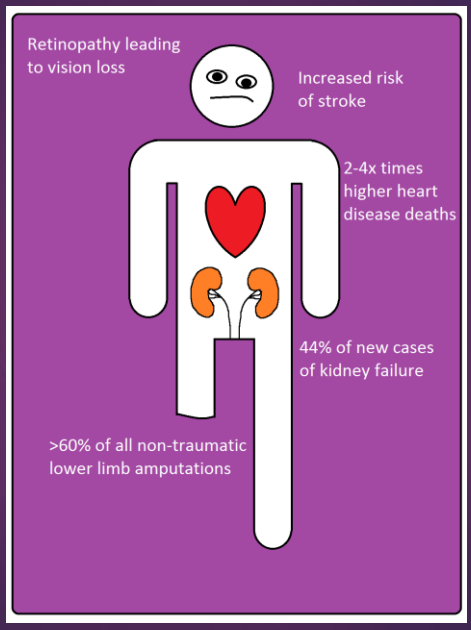
5. Ledermann HP, Morrison WB, Schweitzer ME. MR image analysis of pedal osteomyelitis distribution patterns of spread, and frequency of associated ulceration and septic arthritis. Radiology. 2002;223(3):747-55.

Thanks!


Retinopathy leading to vision loss
Increased risk of stroke
2-4x times higher heart disease deaths
44% of new cases of kidney failure
>60% of all non-traumatic lower limb amputations

Management of Charcot Neuroarthropathy

Andrew Elliott, DPM, JD
Gundersen Health System
September 2018

DISCLAIMER

- No relevant financial relationships
- No conflicts of interest

Treatment Options

- Conservative Treatment
- Pharmacological Treatment
- Surgical Treatment

Conservative Treatment

- ✓ Acute tx focus:
  - ✓ Stabilizing the unstable externally
  - ✓ Allow the inflammation to subside
  - ✓ Allow the Fractures to heal
  - ✓ Plantigrade foot that can be protected in a custom/rocker bottom shoe

Better to start CN treatment earlier rather than later:
24 patients with Eichenholtz Stage 0
11 tx'd within 1mo of onset of s/s with 3mo TCC
13 tx'd ave 3mo after onset of s/s 5mo TCC
All 13 of the delayed treatment group advanced to flatfoot/rockerbottom rigid deformities
But in the early group only 1 did

Chantelau E. The perils of procrastination: effects of early vs. delayed detection and treatment of incipient Charcot fracture.Diabet Med 2005; 22: 1707 -12.

2008;90A:734–9.

Christensen TM, Gade-Rasmussen B, Pedersen LW. Duration of off-loading and recurrence rate in Charcot osteoarthropathy treated with less restrictive regimen with removable walker. J Diabetes Complications 2012;26:430–4.

How important is NWB?

Although the expert consensus remains NWB immobilization in a TCC, literature exists that suggests that continued WB while immobilized does not hinder the

In a study by du Souza et al Patients were initially instructed to be NWB. However, the authors found that patients often did not comply with this instruction.
1) a lack of proprioception and inability to determine how much weight was being placed on the foot due to peripheral neuropathy,
2) poor eyesight secondary to diabetic retinopathy, and
3) poor strength and coordination which made the use of ambulation assistive devices difficult.
The authors found that despite the patients being WB more often than not, only one progressed to deformity of the foot during the treatment period. Thus, they allowed all subsequent patients to be WB as tolerated.

de Souza LJ. Charcot arthropathy and immobilization in a weight-bearing total contact cast. J Bone Joint Surg Am 2008; 90: 7549.

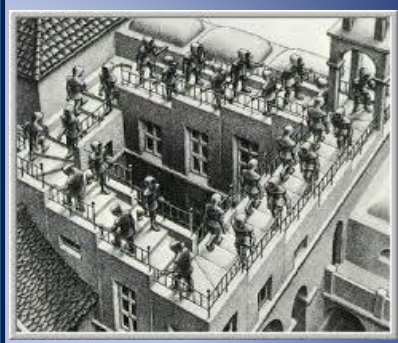
But does it work?

Small study of patients with Eichenholtz Stage 1 midfoot Charcot. The authors found that TCC immobilization provided effective resolution with maintenance of a stable, plantigrade foot in 75% of cases at 32mo, concluding that TCC immobilization remains the mainstay of treatment for midfoot Charcot.
This has been replicated in several other studies.

Myerson MS, Henderson MR, Saxby T, Short KW. Management of midfoot diabetic neuroarthropathy. Foot Ankle Int 1994; 15: 233-41.

Armstrong DG, Todd WF, Lavery LA, Harkless LB, Bushman TR. The natural history of acute Charcot's arthropathy in a diabetic foot specialty clinic. Diabet Med 1997; 14: 357-63.

Sella EJ, Barrette C. Staging of Charcot neuroarthropathy along the medial column of the foot in the diabetic patient. J Foot Ankle Surg 1999; 38: 34-40.



Recurrence? Yes…
Some studies have shown as high as 23% within 27mo
Noncompliance and obesity (>30kg/m²) were the two main predisposing factors

Osterhoff G, Boni T, Berli M. Recurrence of acute Charcot neuropathic osteoarthropathy after conservative treatment. Foot Ankle Int 2013;34:35-9.

Bracing ins

- Charcot Restraint Orthot
  Walker (CROW boot)
- Patellar tendon bearing brace
- Removable walking boot

Immobilization times with these devices are longer compared to those of non-removable devices as patients may remove the device and ambulate without them.

Sinacore DR, Withrington NC. Recognition and management of acute neuropathic (Charcot) arthropathies of the foot and ankle. J Orthop Sports Phys Ther 1999; 29: 736-46.
Sinacore DR. Acute Charcot arthropathy in patients with diabetes mellitus: healing times by foot location. J Diabetes Complications 1998; 12: 287-93.
Richard JL, Almasri M, Schuldiner S. Treatment of acute Charcot foot with bisphosphonates: a systematic review of the literature. Diabetologia 2012; 55: 1258-64.

Pharmacologic Answers?

Bisphosphonates are drugs that

No serious adverse events
A more rapid reduction in skin temperature was noted
however, this reduction was not sustained over time.
Pain reduction was not consistently reported.
Two studies reported longer immobilization times
The overall conclusion was that the use of bisphosphonates is not supported.

Richard JL, Almasri M, Schuldiner S. Treatment of acute Charcot foot with bisphosphonates: a systematic review of the literature. Diabetologia 2012; 55: 1258-64.

- ✓ Zoledronic acid

treat

and t

Pharmacologic Answers?

A randomized controlled trial for intranasal calcitonin as adjunct to conservative tx of CN looked at 32 pts over 6mo.

- ✓ Markers for bone turnover were measured at 3 and 6mo.
- ✓ Significantly greater reduction in ICTP and BALP was noted at 3mo.
- ✓ Reduction in BALP was not seen at 6mo.
- ✓ Daily nasal calcitonin may be an effective adjunctive treatment modality.

Bem R, Jirkovska´ A, Fejfarova´ V, Skibova´ J, Jude EB. Intranasal calcitonin in the treatment of acute Charcot neuroosteoarthropathy: a randomized controlled trial. Diabetes Care 2006; 29: 1392-4.

Bone stimulator?

Hanft et al. study on 31 pts with Stage 1 CN who were followed for an average of 23.3 weeks:

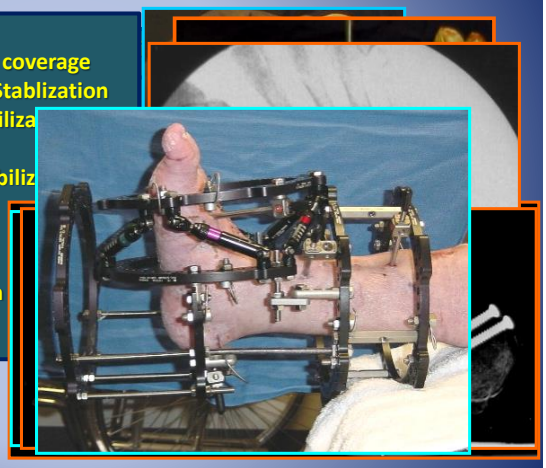
- Tx'd with a TCC or TCC and application of a combined magnetic field bone growth stimulator for 30 min daily.
- Bone stimulator statistically significant reduction with a mean time to osseous consolidation occurring in the study Group 12 wks before the control Group.
- Use of a combined magnetic field bone growth stimulator may be an effective adjunctive modality in the treatment of acute CN.

Hanft JR, Goggin JP, Landsman A, Surprenant M. The role of combined magnetic field bone growth stimulation as an adjunct in the treatment of neuroarthropathy/Charcot joint: an expanded pilot study. J Foot Ankle Surg 1998; 37: 510-15. discussion 550-1.

Surgical Treatment

We got options:

- Exostectomy and soft tissue coverage
- Screw/Staple Compression Stablization
- Multiple Plate & Screw Stabiliza
- Plantar Plate Stabilization
- Locking Plate and Screw Stabiliz
- Multiple Screw Stabilization
- External Fixation Alone
- Percutaneous Stabilization
- Mini-Open Joint Preparation
- Ring External Fixation



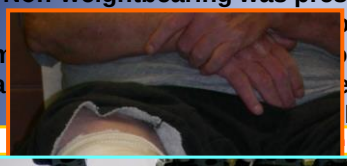
Grim Statistics

Systematic Literature Review (2011)

- ✓ *Results: 111 manuscripts reviewed in entirety*
  - *67: Case Report or Retrospective Case Series*
  - *29: Other [Brace Therapy; TCC; Gait Analysis; Etc.]*
  - *15: QOL/Demographic Studies*
- ✓ *Surgical Tx: 389 Feet; 2.4 year F/U; NWB 3.3 Months*
  - *Recurrent Ulceration: 15/267 (5.7%)*
  - *Deep Infection: 32/264 (12.1%)*
  - *Hardware Failure/Non-unions: 64/264 (24.2%)*
  - *Re-operation: 67/310 (21.6%)*
  - *Trans-tibial Amputation: 29/298 (9.8%)*
- ✓ *Mortality: 330/1138 patients (29%) @ Δ 5yr. F/U*
- ✓ *QOL: ↓ Physical Functioning & General Health; Similar effect to TTA*

Patient Factors that Effect Surgical Outcome

"Non-weightbearing was prescribed and a physical therapist provided



Your foot cannot look, touch, lean, rest, glance, graze, hover, or taunt the ground and the ground is anything in the entire world your foot could come in contact with

Try to stay off of your foot as much as you can

Patient Factors that Effect Surgical Outcome

- ✓*Intelligence + Cognitive Skills*
- ✓*Motivation*
- ✓*Family + Social support network*
- ✓*Expectations*
- ✓*ETOH ± TOB*
- ✓*Compliance*

THANK YOU

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