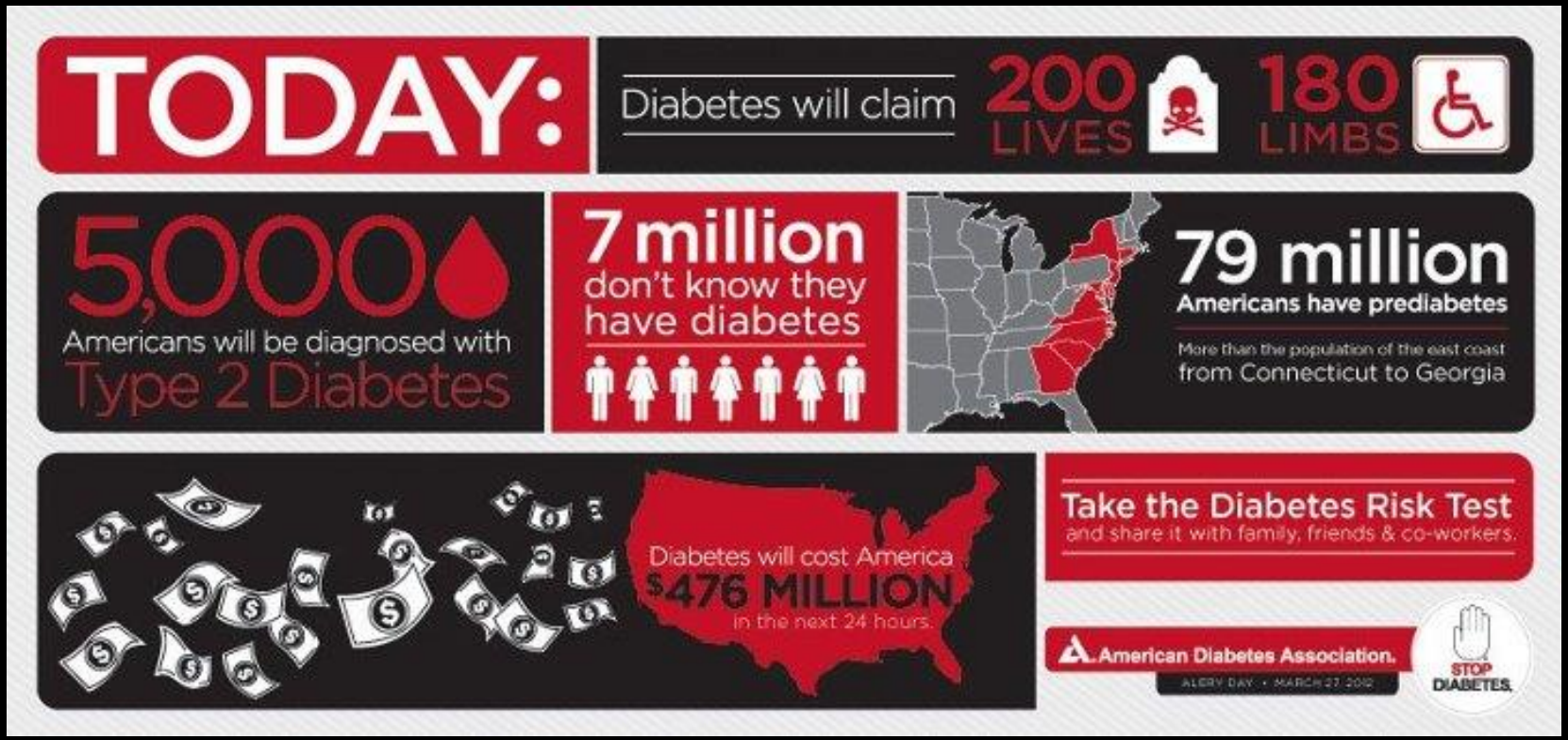
Musculoskeletal Manifestations of Diabetes Mellitus

Connie Montgomery

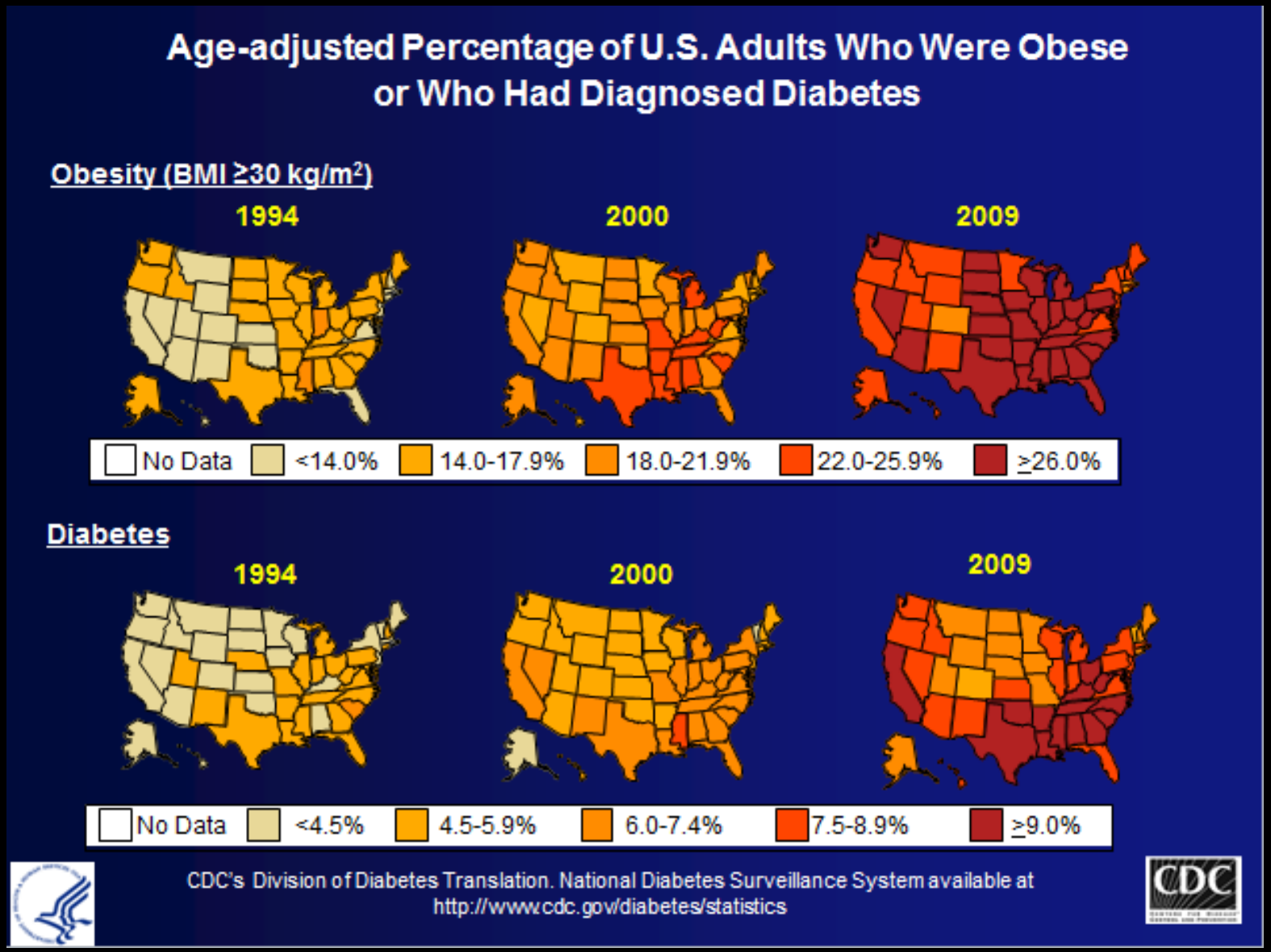
Diabetes in America

- 29.1 million (9.3%) Americans have diabetes
- 86 million (37%) Americans are prediabetic
- Seventh leading cause of death based on death certificates
- 1 in every 10 health care dollars is spent treating diabetes
- $245 billion total cost of diabetes in US in 2012
- Diabetic patients have health care costs 2.3 x higher than non-diabetic patients



American Diabetes Association 2015

Diabetes in America



Musculoskeletal manifestations of diabetes

- Muscles
  - Diabetic myonecrosis
  - Infectious myositis
  - Denervation changes
- Foot
  - Ulcer
  - Osteomyelitis
  - Charcot neuroarthropathy
- Spine
  - Dialysis related spondyloarthropathy
  - Charcot spine
- Associations
  - Calcaneal insufficiency avulsion fracture
  - Dialysis-related amyloidosis
  - Adhesive capsulitis
  - Dupuytren’s contracture
  - Flexor tenosynovitis
  - Carpal tunnel syndrome

MUSCLES

- Diabetic myonecrosis
- Infectious myositis
- Denervation changes

Diabetic myonecrosis

- Long-standing, poorly controlled diabetes
  - ~50% end organ complications of diabetes (retinopathy, nephropathy, or neuropathy)
- Clinical: acute severe lower extremity pain without fever or leukocytosis
- Pathogenesis: uncertain, microvascular occlusion

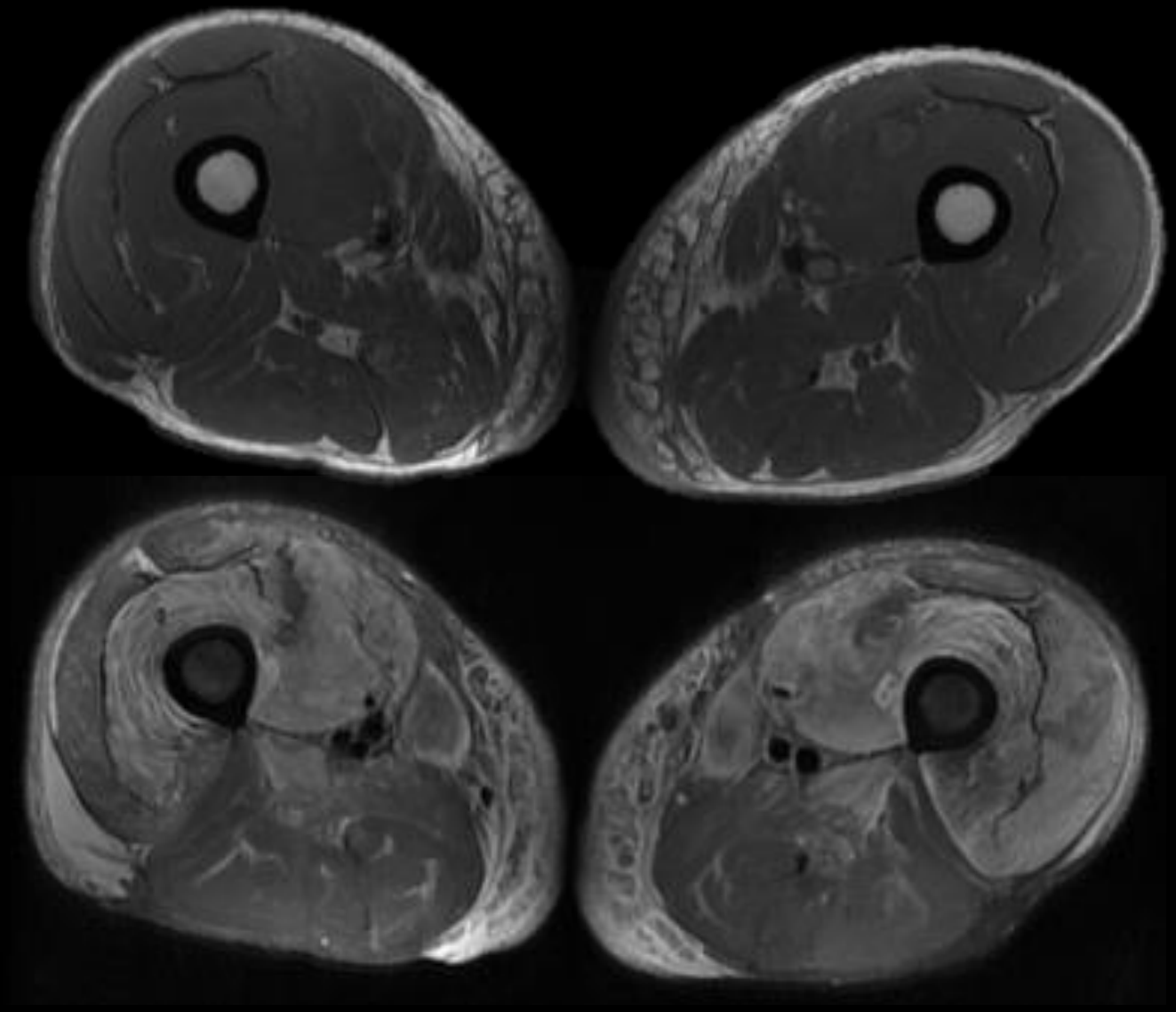
Diabetic myonecrosis

Distribution:
anterior thigh (vastus);
posterior calf (gastroc);
noncontiguous muscles

T1: isointense

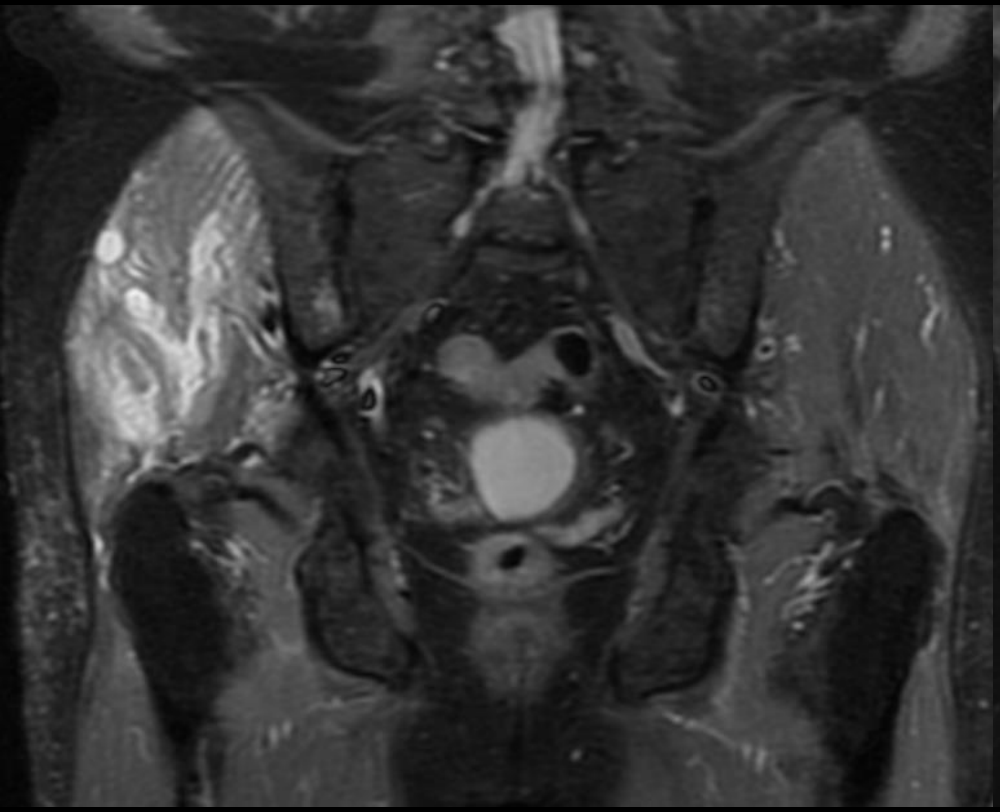
T2: hyperintense

E+: central areas of hypoenh+ (myonecrosis);
contrast useful to demonstrate myonecrosis but is contraindicated with renal dysfunction

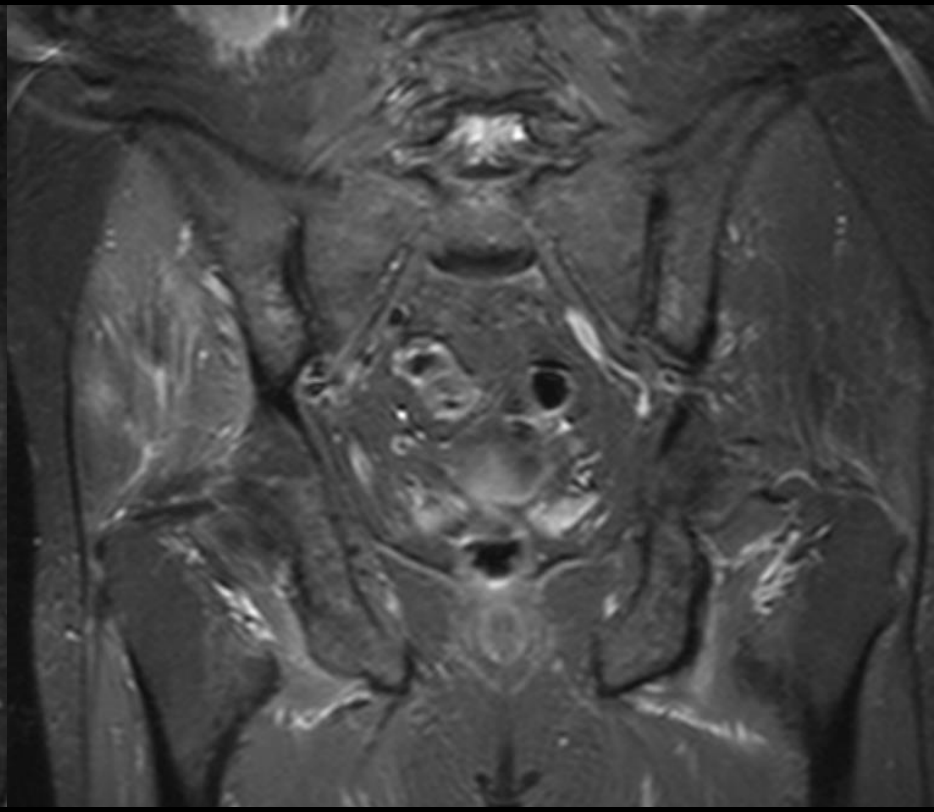


Courtesy of Brady Huang

Diabetic myonecrosis



Presentation



3 weeks later, conservative treatment

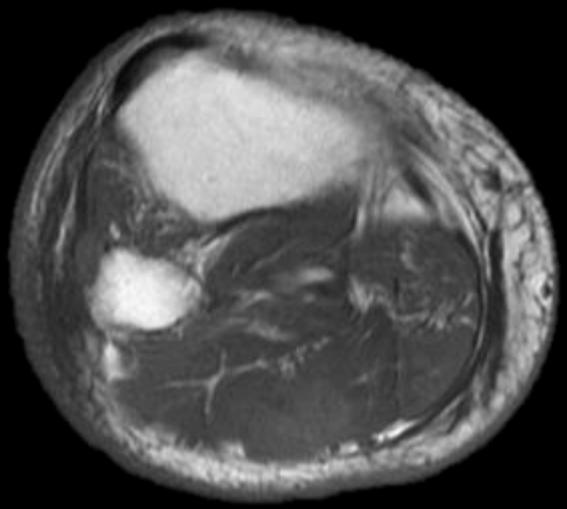
Treatment	Mean time to resolution, days
NSAIDs	28.5 (10-60)
Bedrest	41.7 (5-120)
Physiotherapy	76.5 (21-180)
Surgery	81.6 (25-120)

Course is self limited and treated conservatively. Surgery and physiotherapy in the acute phase increases morbidity.

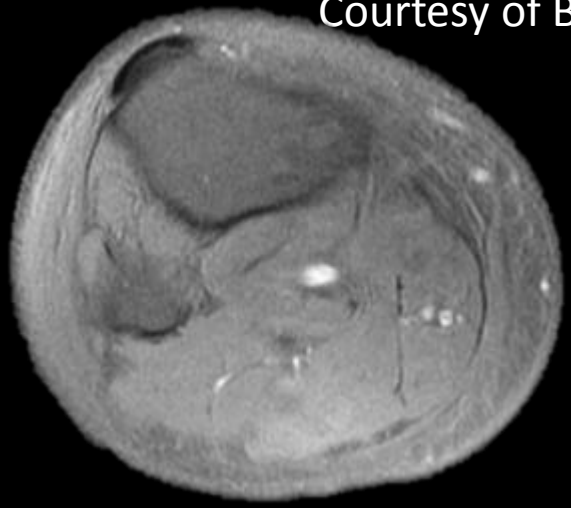
Courtesy of Mini Pathria

Recurrent diabetic myonecrosis

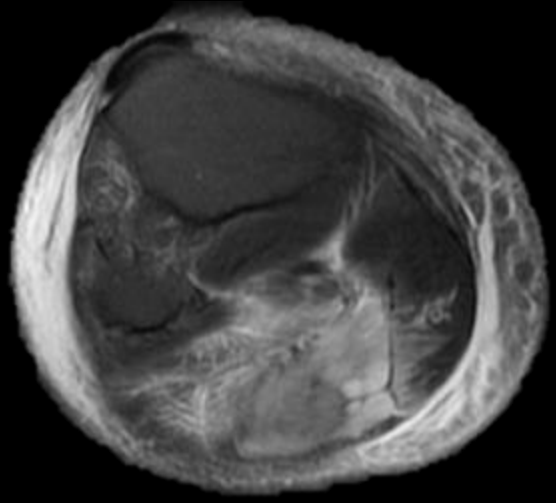
Courtesy of Brady Huang



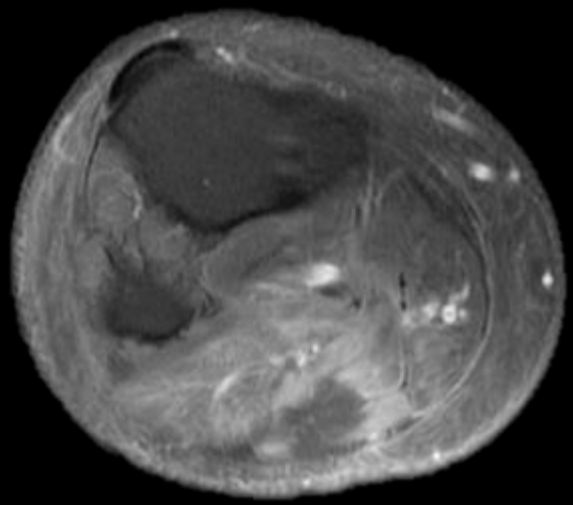
T1



Precontrast



T2

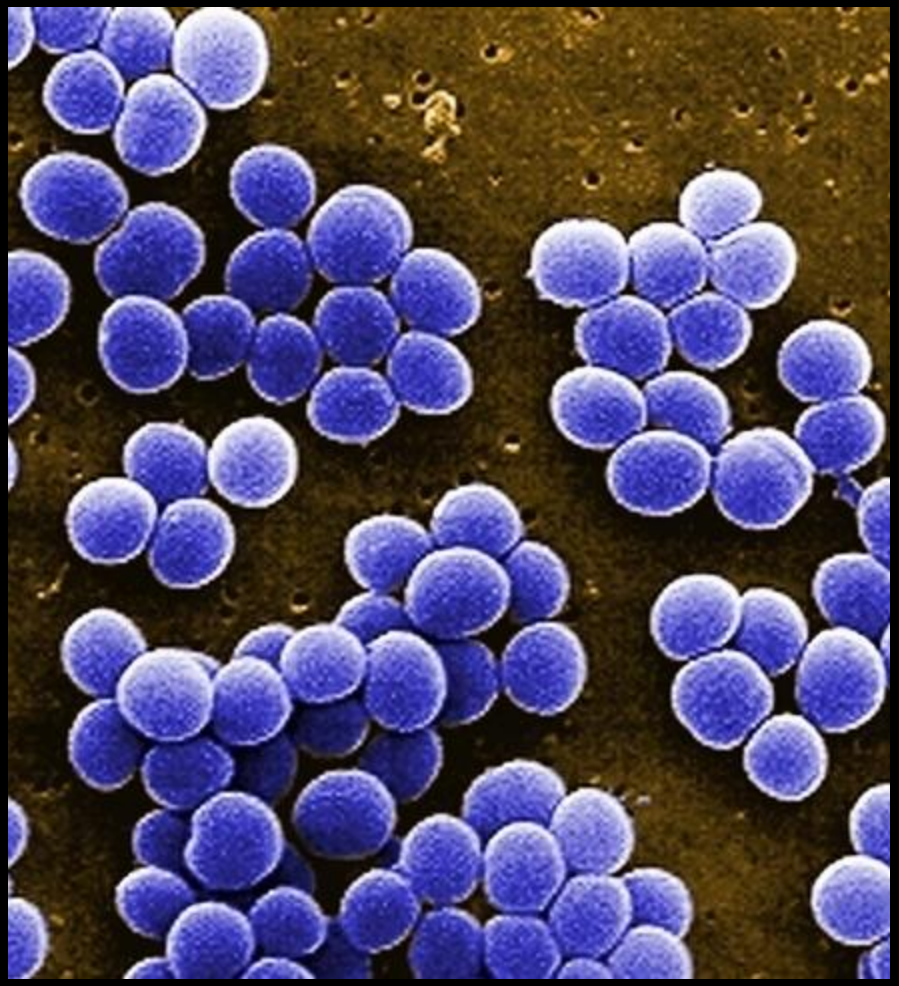


Postcontrast

Recurrence rate 45%, highest recurrence rate in patients treated surgically

Infectious myositis

- Predisposed due to underlying immune dysfunction
  - Hematogenous spread
  - Local spread: osteomyelitis, cellulitis
- Clinical: acute presentation with fever, elevated WBC
- Tx: antibiotics and abscess drainage

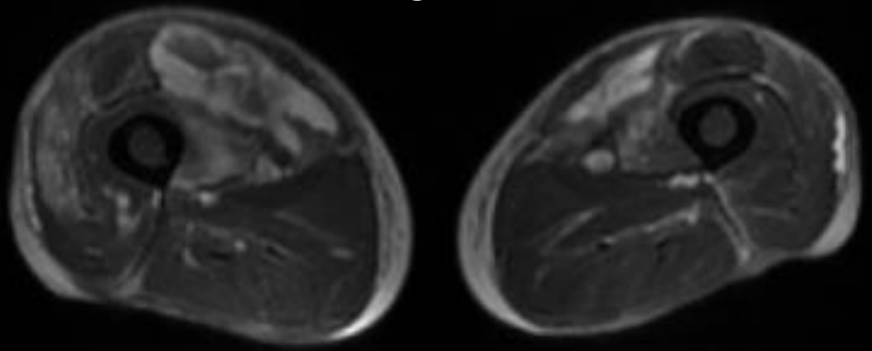


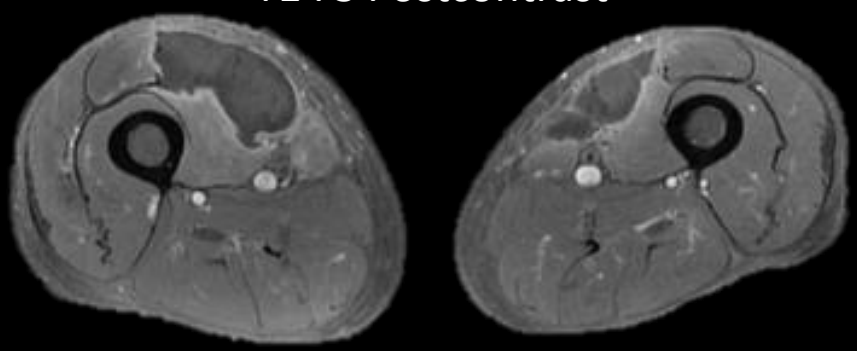
Staph. aureus

Infectious myositis

STIR

T1 FS Postcontrast



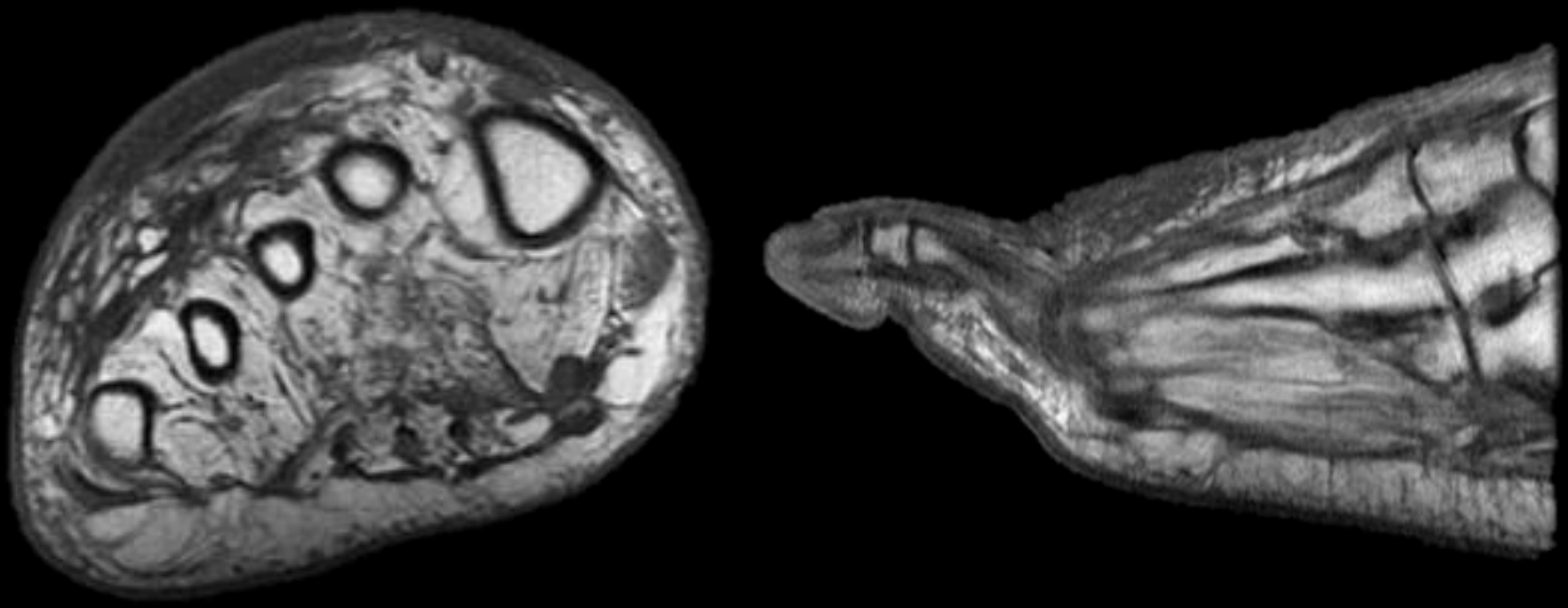


Hallmark of muscle infection is fluid collection inside the muscle.

Infectious myositis

- Abscess formation not required for diagnosis.
- Muscle edema may be the sole abnormality.
- Clinical history and presentation may be key!

Muscle denervation



- Denervation and atrophy of the intrinsic musculature of the foot is not a benign finding! Role in development in claw/hammer toe deformities, which is linked to ulceration.
- Atrophy of the intrinsic musculature of the foot may be an early marker for neuropathy.

THE DIABETIC FOOT

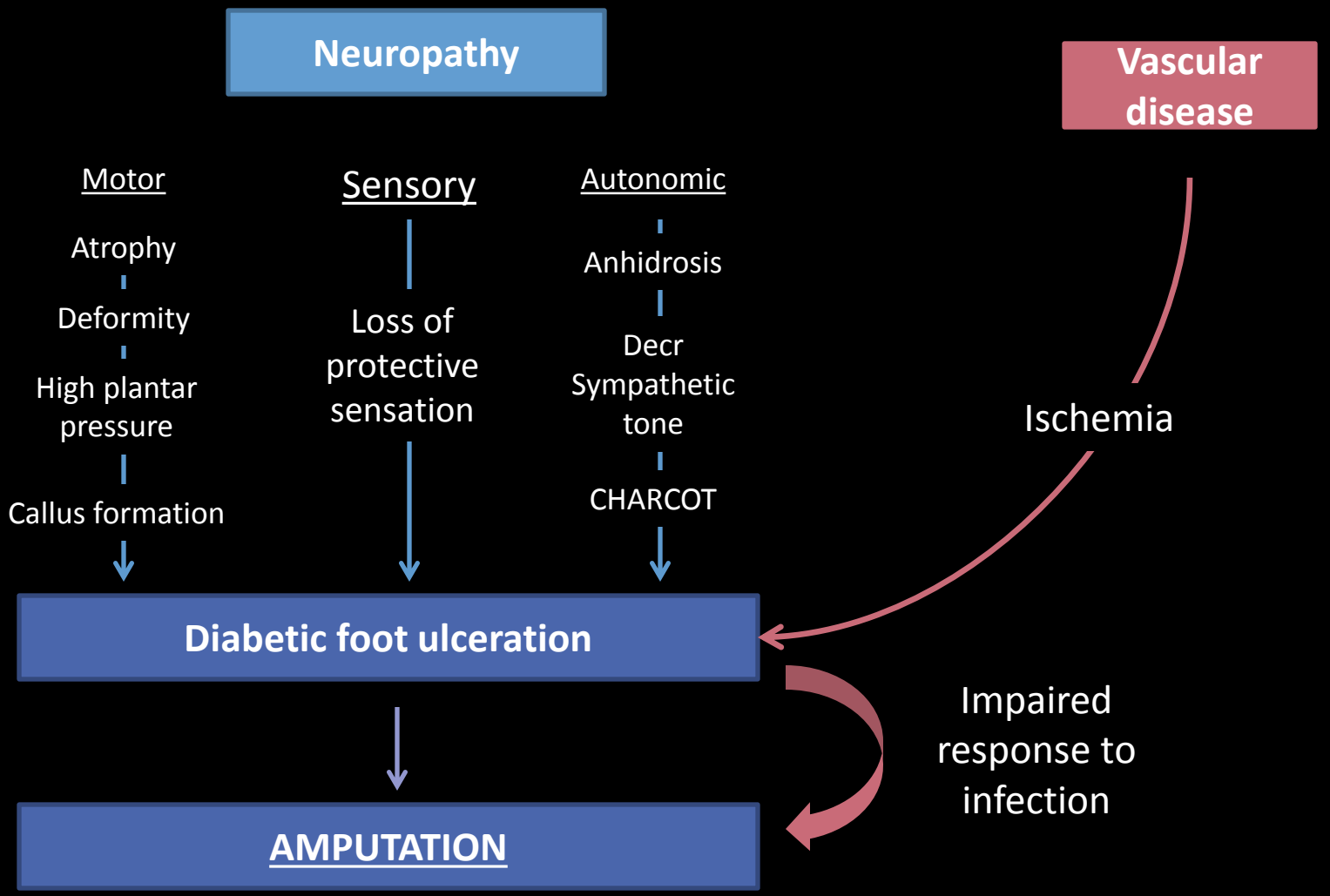
- Osteomyelitis
- Neuropathic osteoarthropathy
- Superimposed infection

Diabetic foot ulcer

- 15% diabetics will develop a lower extremity ulcer during the course of their disease
  - 7-20% of these patients will subsequently require an amputation
  - Diabetic foot is the most common cause of nontraumatic lower extremity amputations in US
- Management of complicated foot ulcer is the leading cause for hospitalization for patients with diabetes

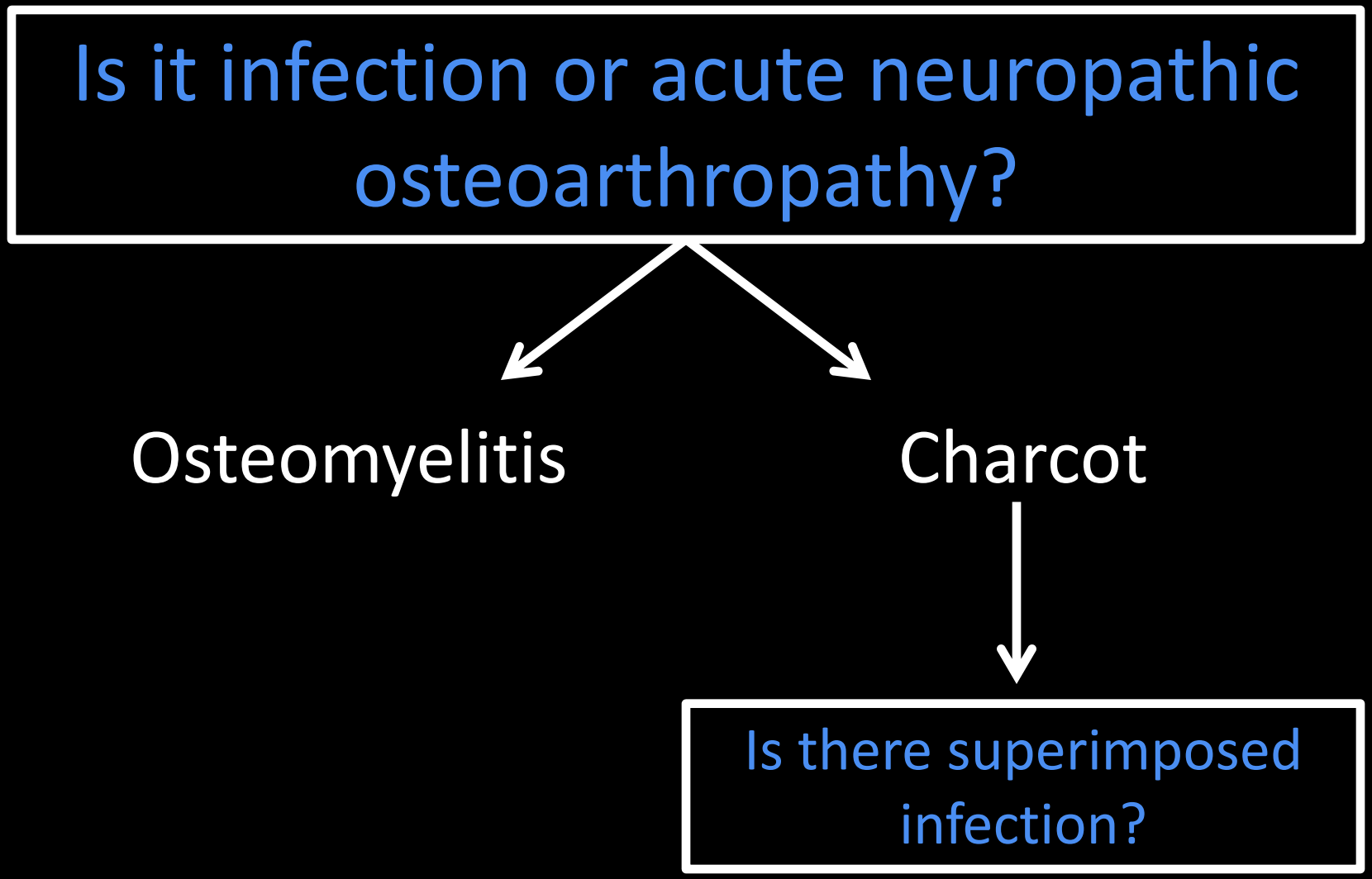
Diabetic Foot Disorders: A Clinical Practice Guideline. J Foot & Ankle Surgery 2006.

Diabetic foot ulcer



Diabetic Foot Disorders: A Clinical Practice Guideline. J Foot & Ankle Surgery 2006.

Evaluation of the inflamed diabetic foot

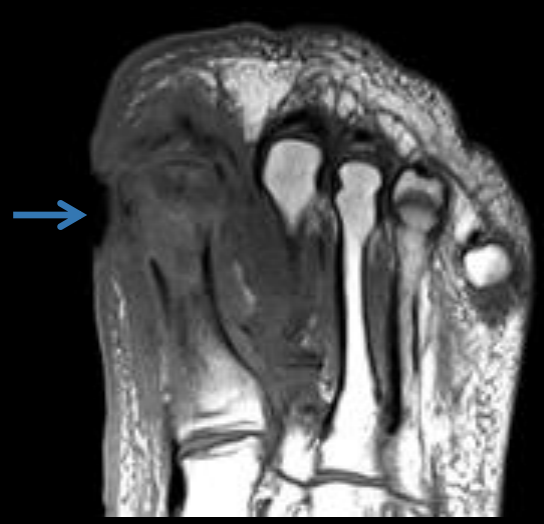


Osteomyelitis

Nearly all patients with diabetes-related osteomyelitis have an ulcer overlying the site of bone infection.

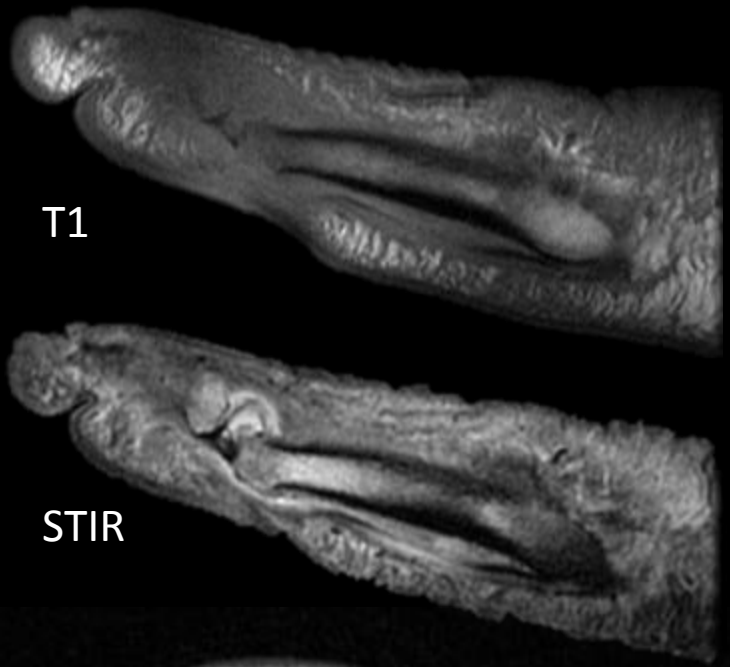
Forefoot > Hindfoot
Plantar aspect MT heads
Tip of great toe distal phalanx
Plantar aspect of heel

Track ulcer or sinus tract to bone and assess the underlying marrow signal.



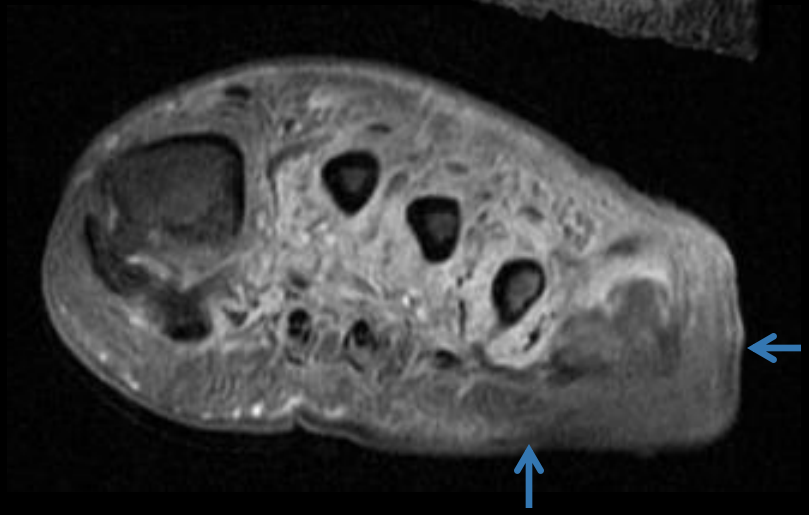
Osteomyelitis

DRY GANGRENE



T1

STIR



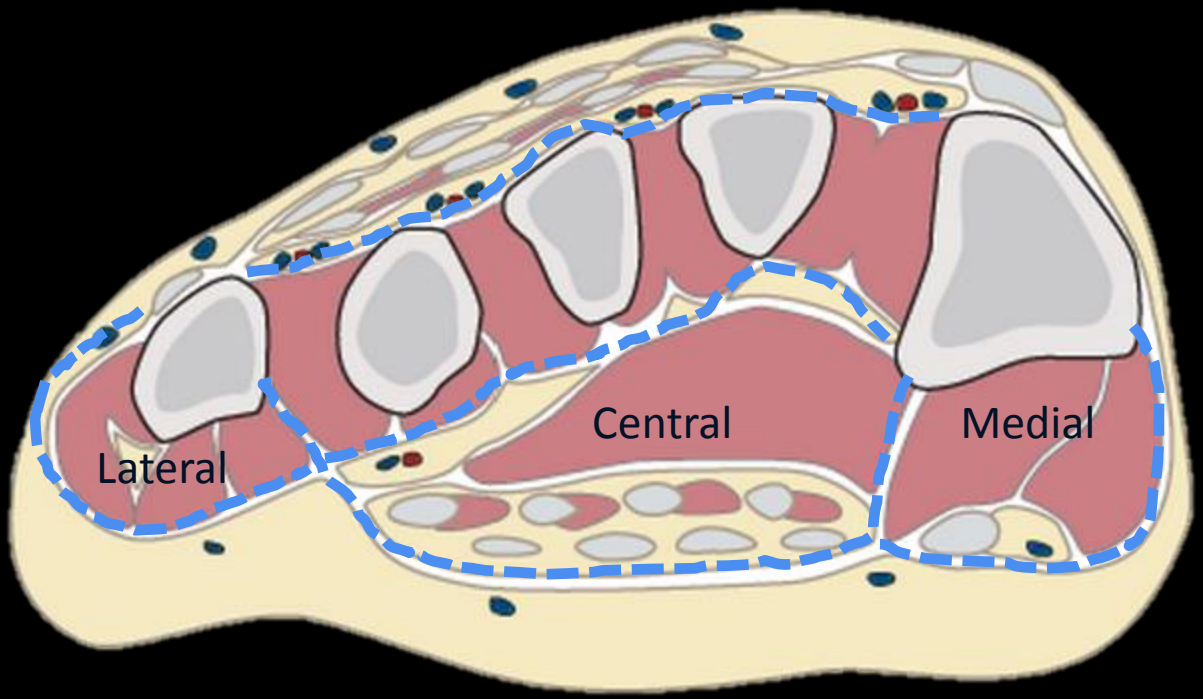
Postcontrast

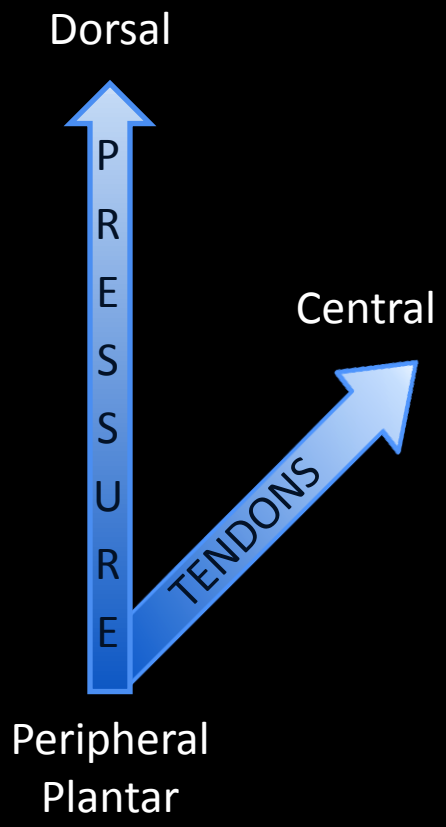
WET GANGRENE

Postcontrast

- Contrast helpful to delineate nonenhancing nonviable bone and tissue.
- Sharp demarcation between viable and nonviable tissue.

Pathways for spread of infection





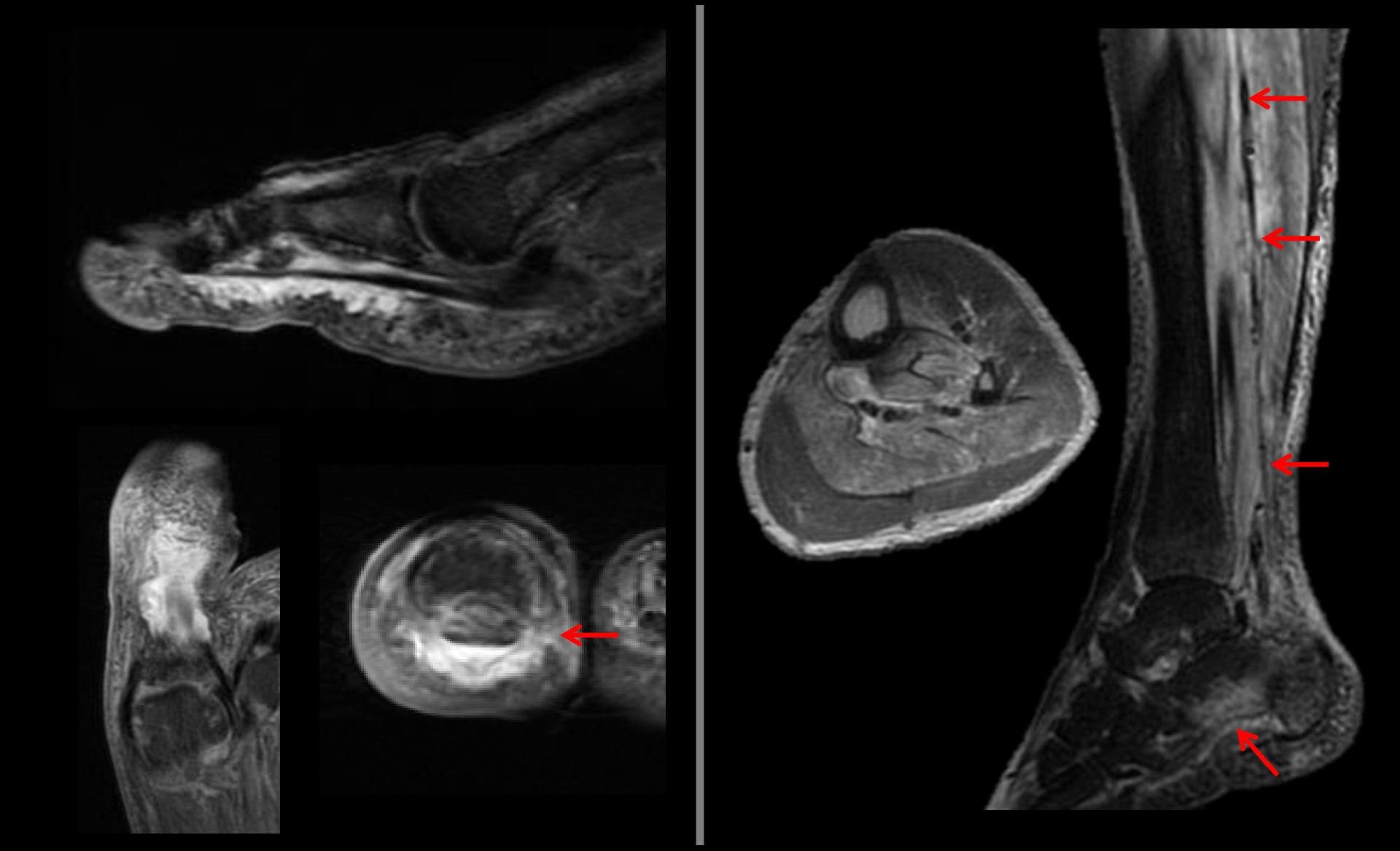
AbDM
FDM brevis

AdH, QP
FDB, FDL*t*
Lumbricals

FHB, AbH
FHL*t*

The central compartment provides a pathway for spread of infection from the plantar aspect of the foot into the posterior compartment of the calf.

Pathways for spread of infection

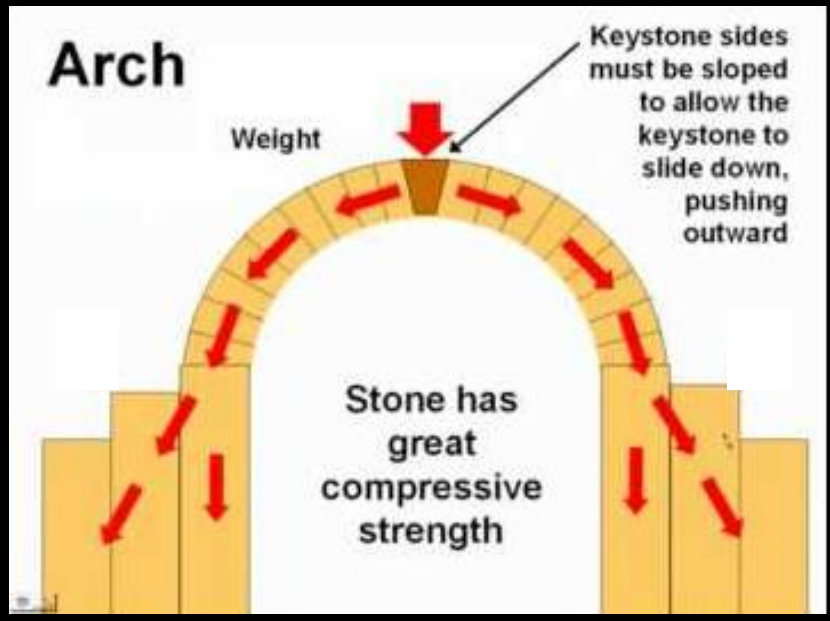


Acute Charcot Osteoarthropathy

- Pathogenesis not fully understood
  - Cumulative trauma to insensate joints
  - Autonomic dysfunction → bone hyperemia and resorption
  - Bone destruction, joint subluxation
- Midfoot predominant
  - Lisfranc (TMT) > talonavicular

  intertarsal > Chopart

  > tibiotalar > subtalar



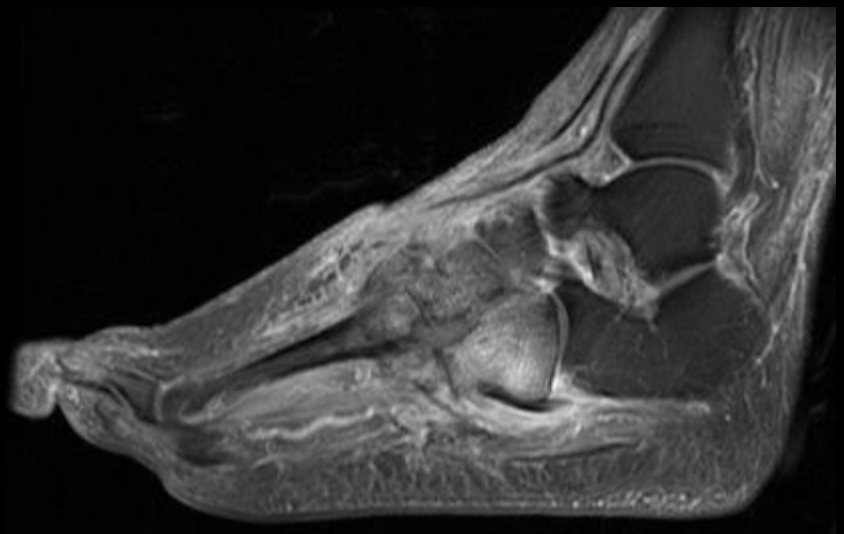
http://abbey921.edu.glogster.com/the-roman-arch

Acute Charcot Osteoarthropathy

Acute phase: XR findings are normal.

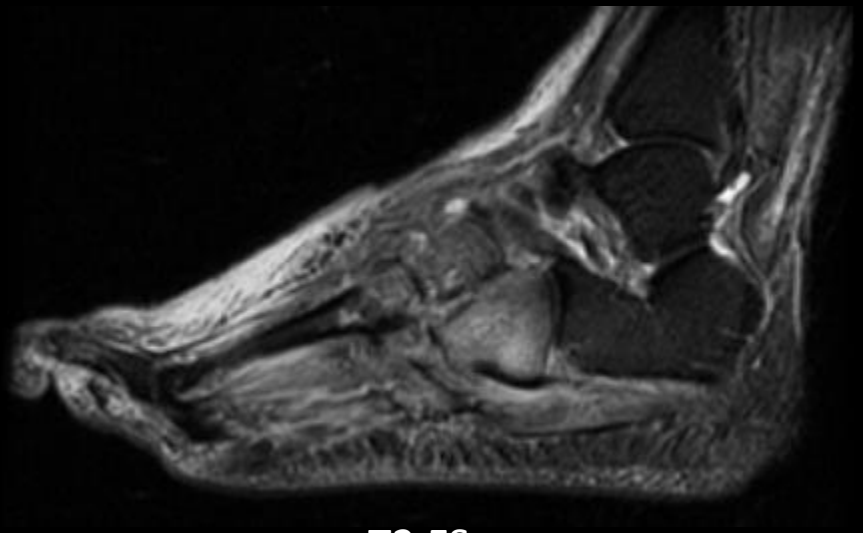
Acute Charcot Osteoarthropathy

T1 Precontrast



T1 Postcontrast

- In acute phase, signal alteration for neuropathic osteoarthropathy mimics osteomyelitis and cannot be use to differentiate between the two entities.
- Location and distribution of findings are key.



T2 FS

Evaluation of the inflamed diabetic foot

Is it infection or acute neuropathic osteoarthropathy?

Osteomyelitis

- Inflamed foot with ulcer
- Forefoot, hindfoot
- X-rays normal initially
- MR: focal marrow edema in bone adjacent to ulcer

Charcot

- Inflamed foot +/- ulcer
- Midfoot
- X-rays normal initially
- MR: regional marrow edema centered at the joints and subchondral bone

Time course for Charcot destruction

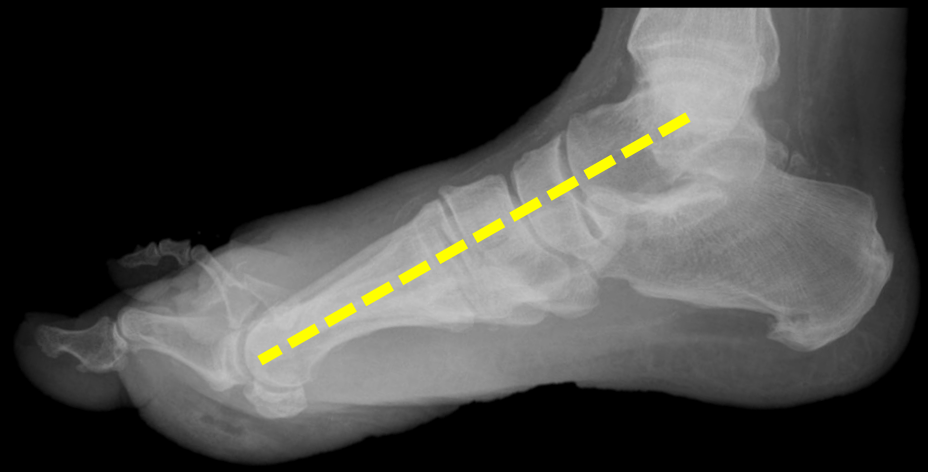
2 months

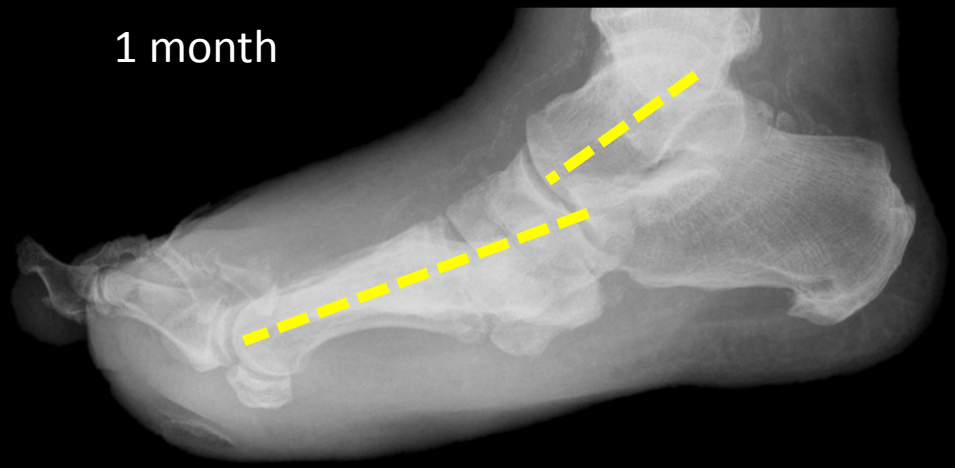
8 months

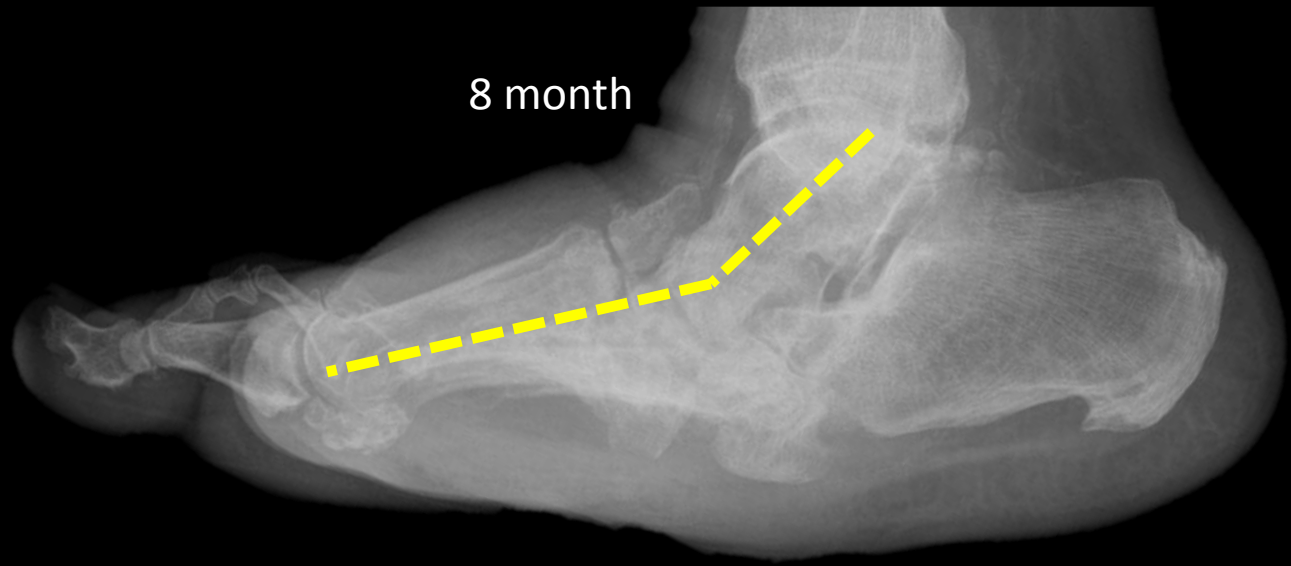
Early recognition of and intervention for Charcot osteoarthropathy (before x-ray changes) has been shown to reduce morbidity.

Courtesy of Brady Huang

Chronic Charcot





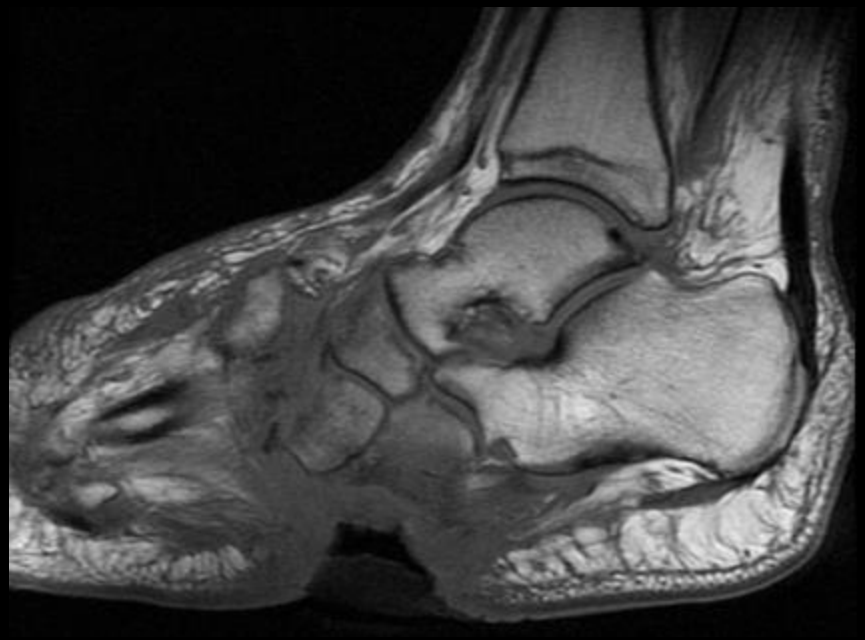


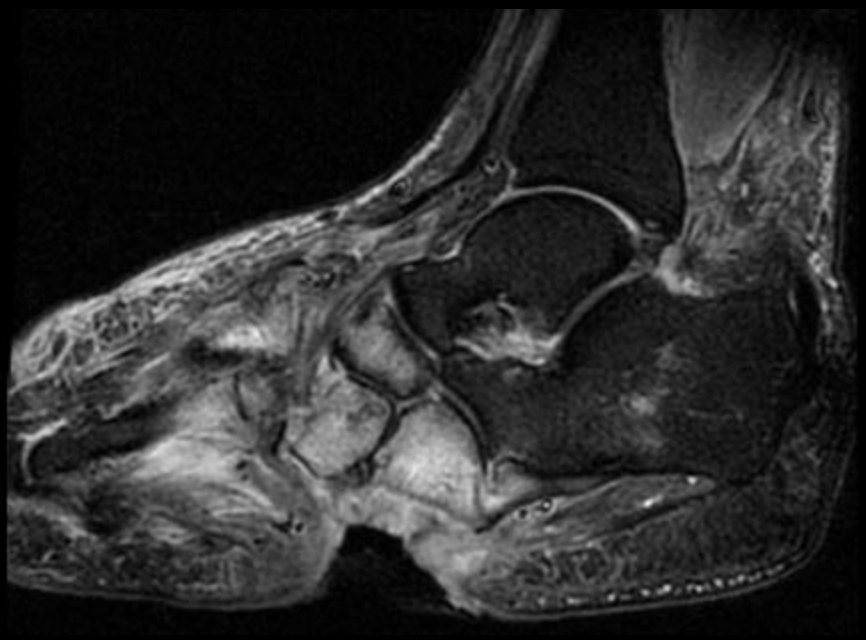
Five D's of Charcot
Density (normal)
Distension (joint effusion)
Debris
Destruction (cartilage)
Disorganization

Chronic Charcot

Five D's of Charcot
Density (normal)
Distension (joint effusion)
Debris
Destruction (cartilage)
Disorganization

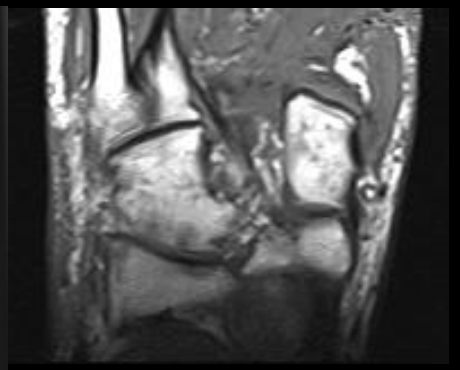
Charcot foot vs superimposed infection

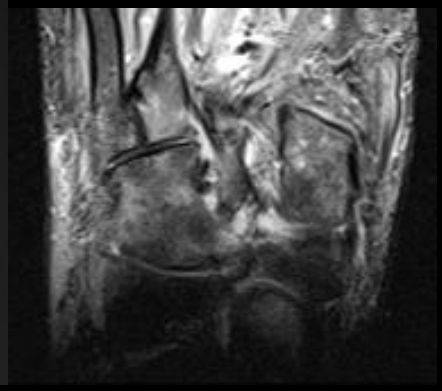




Midfoot collapse predisposes to ulcers in the midfoot which is otherwise an unusual site of ulceration and osteomyelitis.

Superimposed infection: Marrow changes

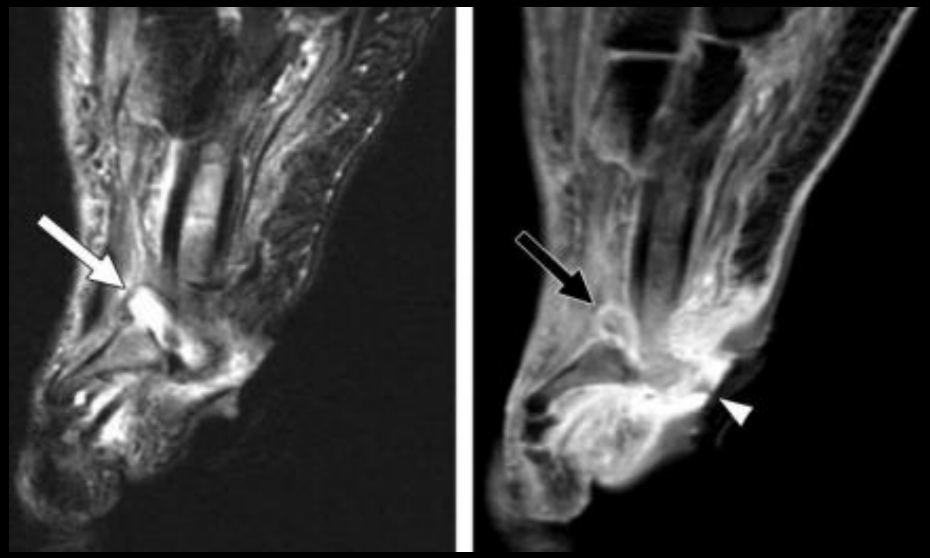




Confluent marrow changes involving the entire bone adjacent to an ulcer favors infection. Foci of marrow edema in sites remote from an ulcer in a Charcot foot are more likely to be related to neuropathy rather than infection.

Superimposed infection: Joint effusion

NOT INFECTED

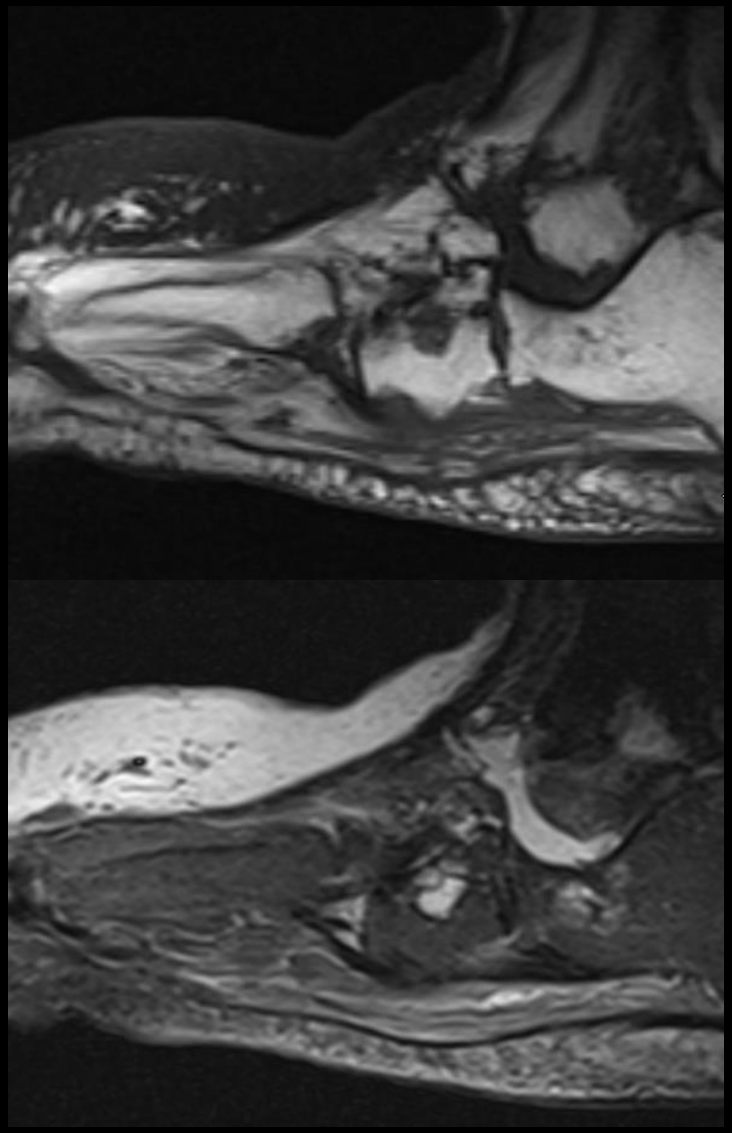


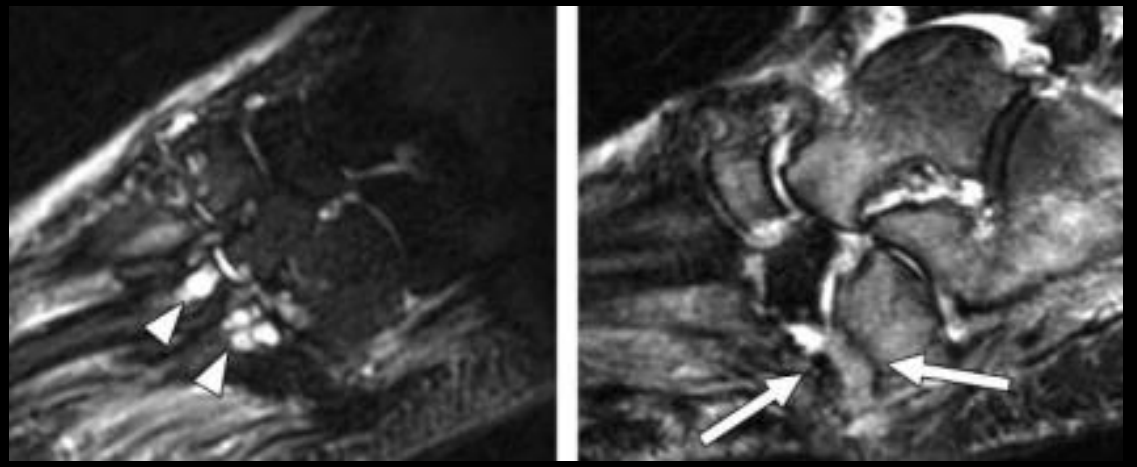
INFECTED

Joint effusions are common in neuropathic joints , and do not automatically imply infection. Thicker or more diffuse rim enhancement with more pronounced adjacent soft tissue abnormality favors presence of superimposed infection.

Ahmadi ME et al. Radiology. 2006 Feb;238(2):622-31.

Superimposed infection: Subchondral cysts

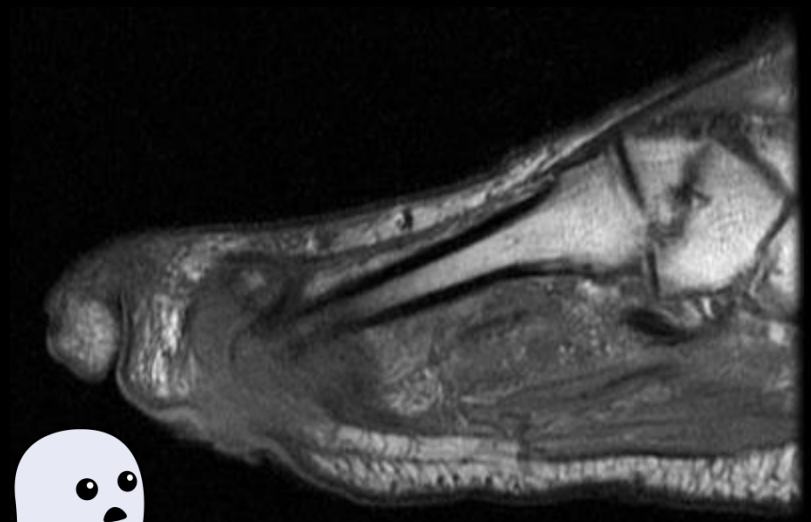




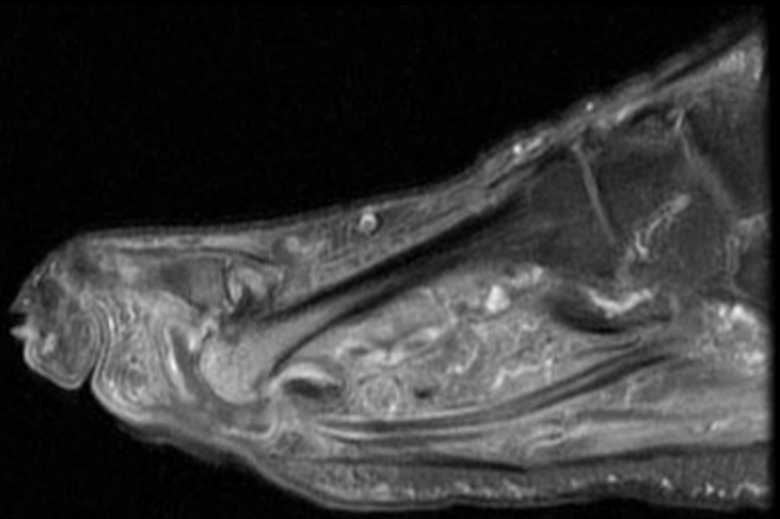
- Presence of subchondral cysts essentially excludes osteomyelitis of the involved bone.
- Disappearance of subchondral cysts or joint bodies is highly suggestive of infection.

Ahmadi ME et al. Radiology. 2006 Feb;238(2):622-31.

Superimposed infection: Ghost sign

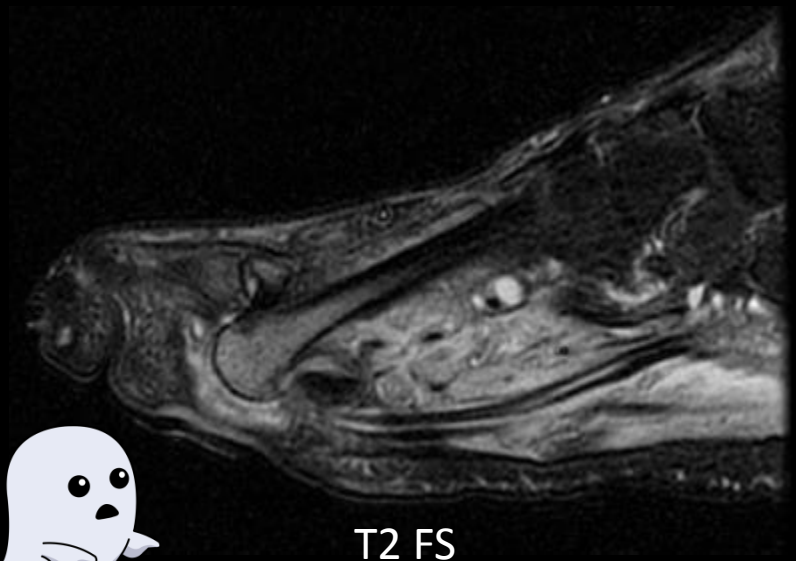


T1 Precontrast



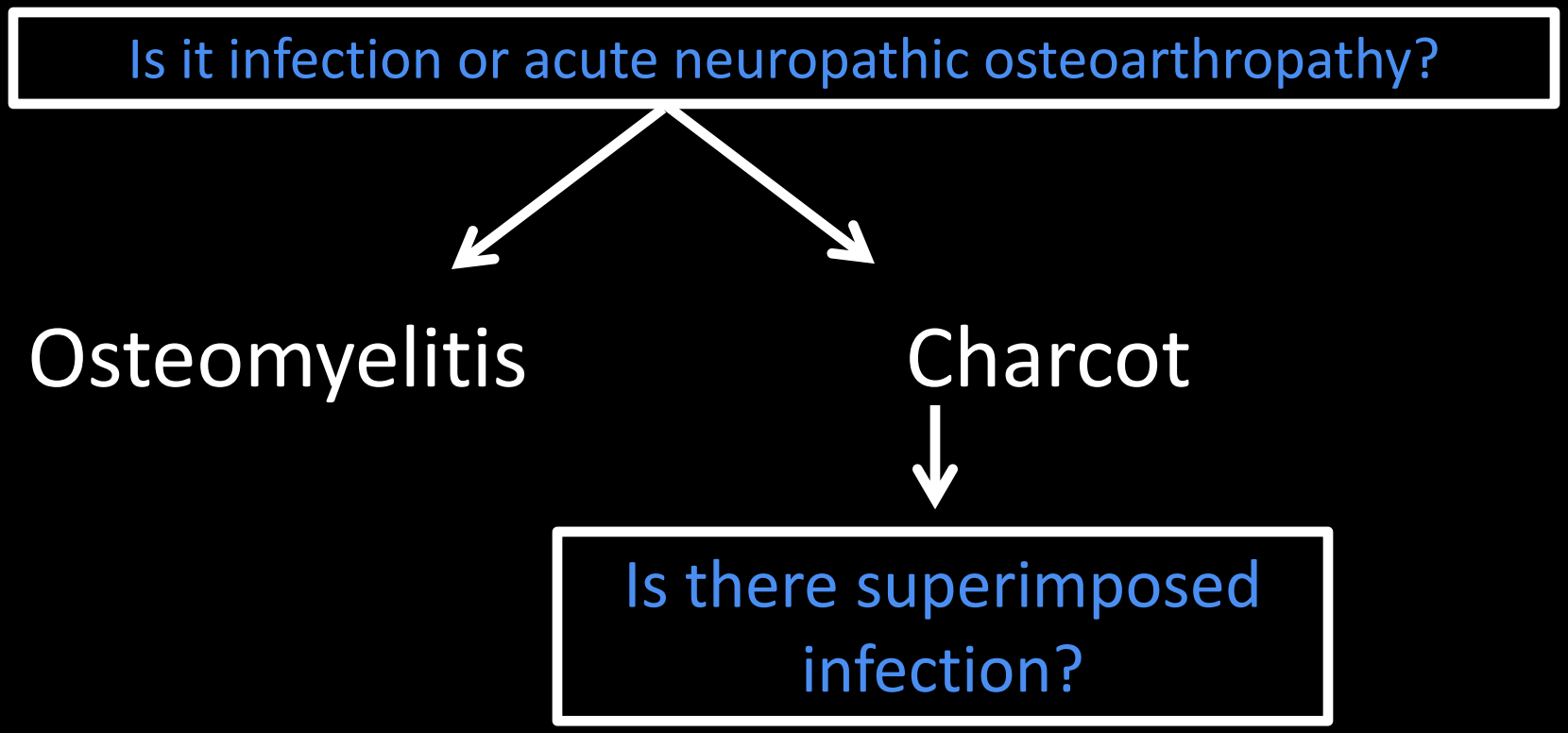
T1 Postcontrast

- Ghost sign refers to bones that “disappear” on T1 WI and “reappear” on T2 WI or postcontrast images.
- Presence of this sign is indicative of neuroarthropathy with superimposed osteomyelitis.



T2 FS

Evaluation of the inflamed diabetic foot



<u>Superimposed infection</u>

- Inflamed foot with ulcer
- X-rays: joint deformity
- MR: confluent marrow edema near ulcer

<u>Charcot</u>

- Inflamed foot +/- ulcer
- X-rays: joint deformity
- MR: little or regional articular-base marrow edema

Spine

- Dialysis-associated spondyloarthropathy
- Neuropathic spine
- Infectious spondylodiskitis

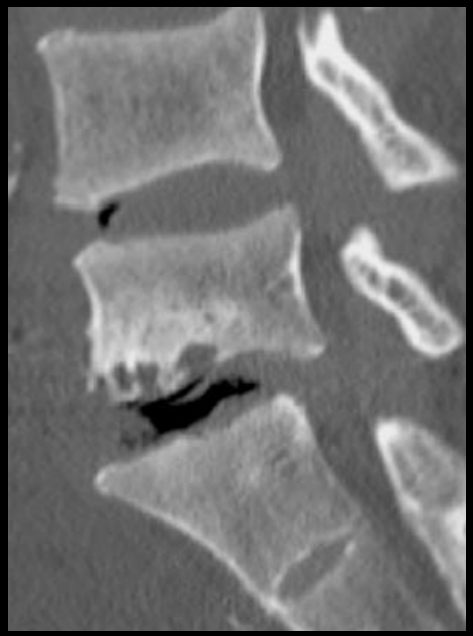
Dialysis-associated spondyloarthropathy

- Amyloid deposition in patients on long-term dialysis
- Occurs in appendicular and axial skeleton
- Axial:
  - Lower cervical spine predilection
  - Endplate erosion and cyst formation with minimal osteophyte formation
  - Rapid progression with frequent subluxation and spondylolisthesis

Dialysis-associated spondyloarthropathy

Courtesy of Tudor Hughes

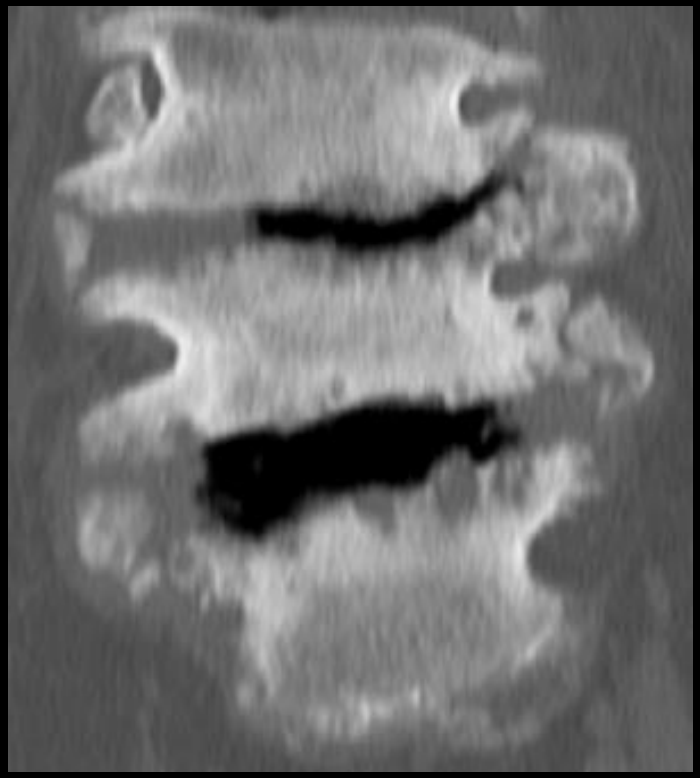
Dialysis-associated spondyloarthropathy

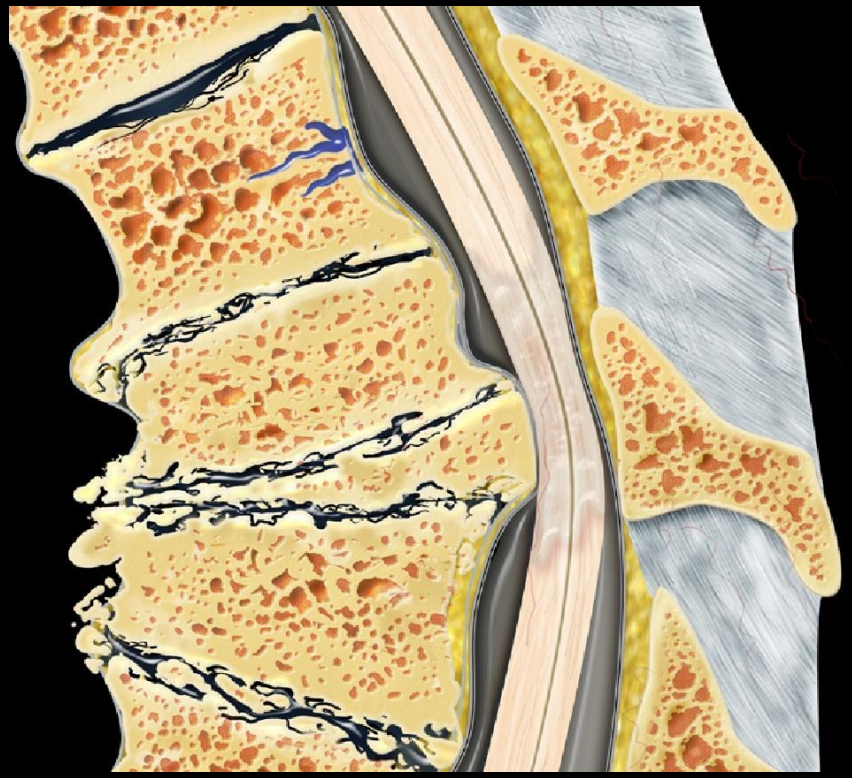


- Majority of cases of dialysis-associated spondyloarthropathy demonstrate low T2 signal in the disc space, which essentially allows the exclusion of infection.
- Often coexists with amyloid deposition in other joints (wrists, shoulders, hips). Radiographic evidence of erosions other sites can help clinch the diagnosis.

Baker JC et al. Radiographics. 2012 Nov-Dec;32(7):1959-74.

Neuropathic Spine





- Typically thoracolumbar or lumbar involvement
- Five Ds – joint debris, disorganization/subluxation, disc space narrowing, endplate erosion

Baker JC et al. Radiographics. 2012 Nov-Dec;32(7):1959-74.

Early stage neuropathic spine

Early stage of neuropathic spine mimics Modic type 1 degenerative changes.

Lacout A, et al. AJR Am J Roentgenol. 2009 Dec;193(6):W505-14.

Neuropathic Spine vs Infection

Vacuum disk, debris, disorganization (spondylolisthesis), and involvement of facet joint are features commonly seen in neuropathic spine but not in infectious diskitis.

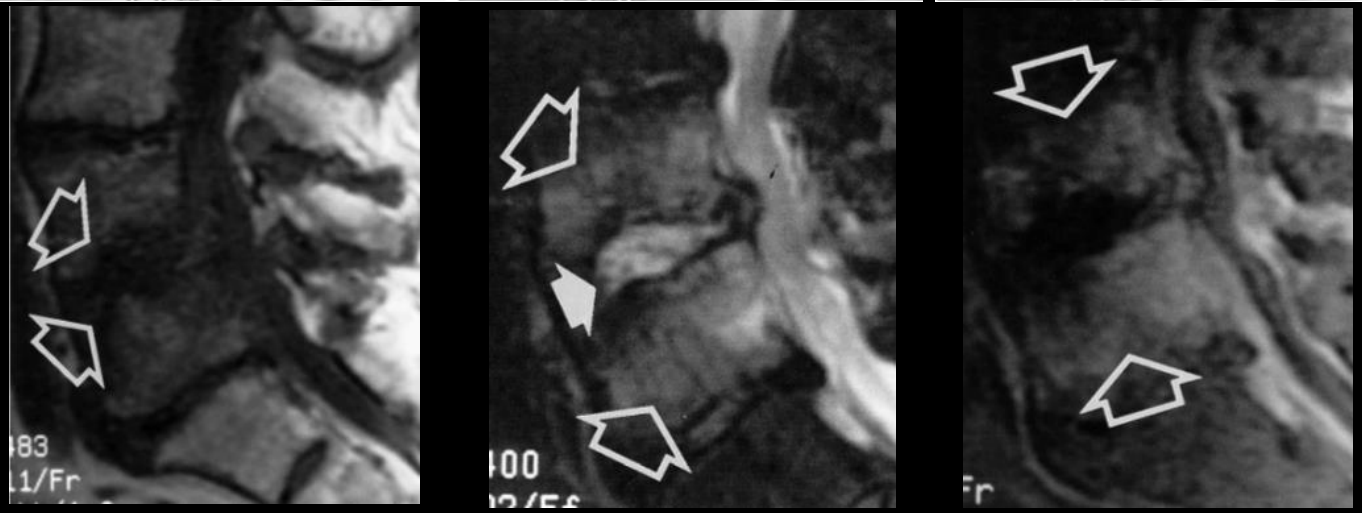
Lacout A, et al. AJR Am J Roentgenol. 2009 Dec;193(6):W505-14. Wagner SC et al. Radiology. 2000 Mar;214(3):693-9.

Neuropathic Spine vs Infection

T1 T2 Postcontrast

<u>Infection</u>
Diffuse disk enh+
Endplate VB enh+

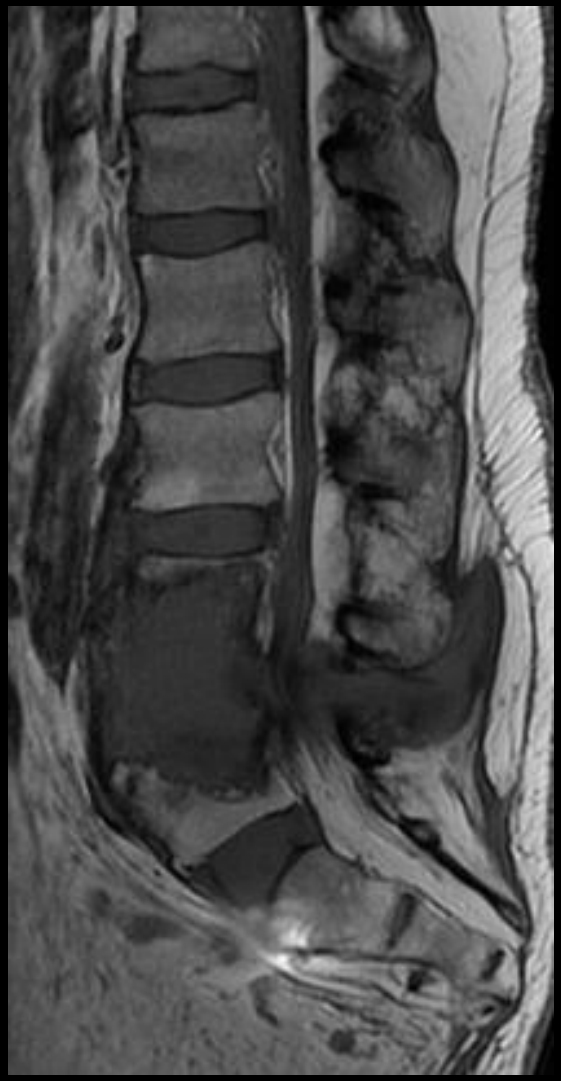
<u>Neuropathic</u>
Rim disk enh+
Diffuse VB enh+



Intrinsic disc signal is not a useful differentiator.
Gadolinium enhancement features are helpful discriminators.

Wagner SC et al. Radiology. 2000 Mar;214(3):693-9.

Neuropathic Spine vs Infection



Courtesy of Brady Huang

Neuroarthropathy may be difficult to distinguish from infection.
Tissue sampling may be necessary to distinguish.

Spine manifestations of diabetes

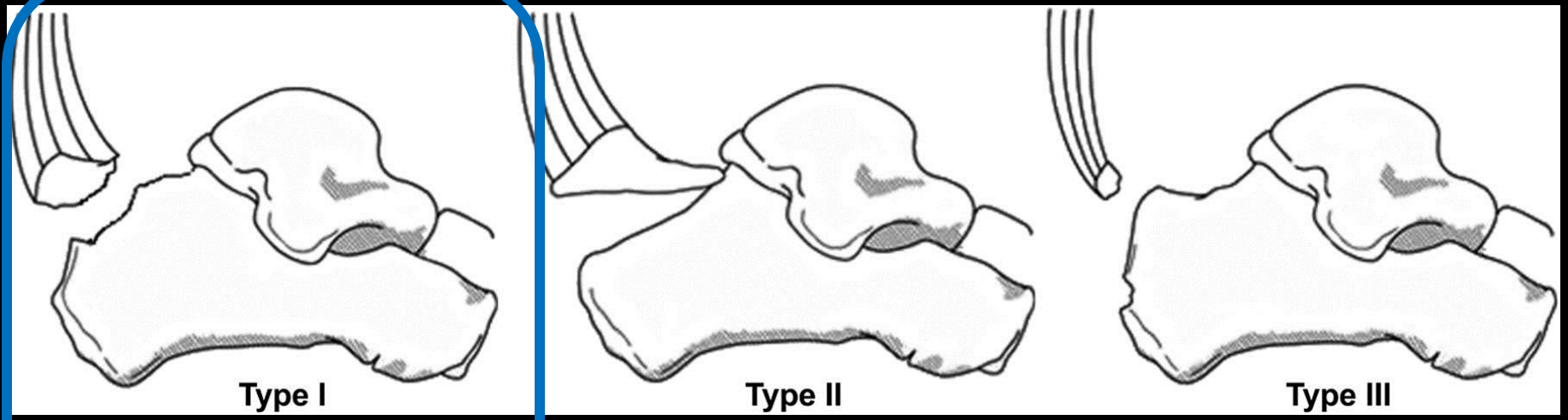
	Dialysis spondylo-Arthropathy	Neuroarthropathy	Infection
Location	Cervical	Typically lumbar	Any level Lumbar > thoracic
Facet involvement		Common	Less common
Disc space	Typically low T2 Symmetric (anterior)	High T2 Vacuum disc Asymmetric	High T2 Symmetric (anterior)
Disc space enhancement	Moderate enh of amyloid	Rim enh	Diffuse enh
Endplate	Erosion Minimal osteophyte Subluxation	Debris Disorganization Subluxation	Osteopenia
Vertebral body		Low T1, High T2 Diffuse	Low T1, High T2 Endplate

Wagner SC et al. Radiology. 2000 Mar;214(3):693-9.

ASSOCIATED MANIFESTATIONS

- Calcaneal insufficiency avulsion fracture
- Dialysis-related amyloidosis
- Adhesive capsulitis
- Dupuytren’s contracture
- Flexor tenosynovitis
- Carpal tunnel syndrome

Calcaneal insufficiency avulsion fracture



Elderly
Osteoporosis, diabetes

Younger patients
Trauma

- Extra-articular fractures of the posterior calcaneus with separation of the avulsed fragment
- Altered gait (avoidance of weight bearing on ulcer) and corticosteroid use (renal transplant) may be predisposing factors
- Higher incidence of infection, nonunion, malunion, and failure of fixation
- May be the first manifestation of neuropathic arthropathy

Kathol MH et al. Radiology. 1991 Sep;180(3):725-9.

Calcaneal insufficiency avulsion fracture

56 yo F DM and kidney transplant. Walking with walker when felt a “crack” in her left ankle.

Courtesy of Eddie Smitaman

Calcaneal insufficiency avulsion fracture

When she was being transported in the car to the hospital for evaluation, she felt a similar "crack" in her right ankle.

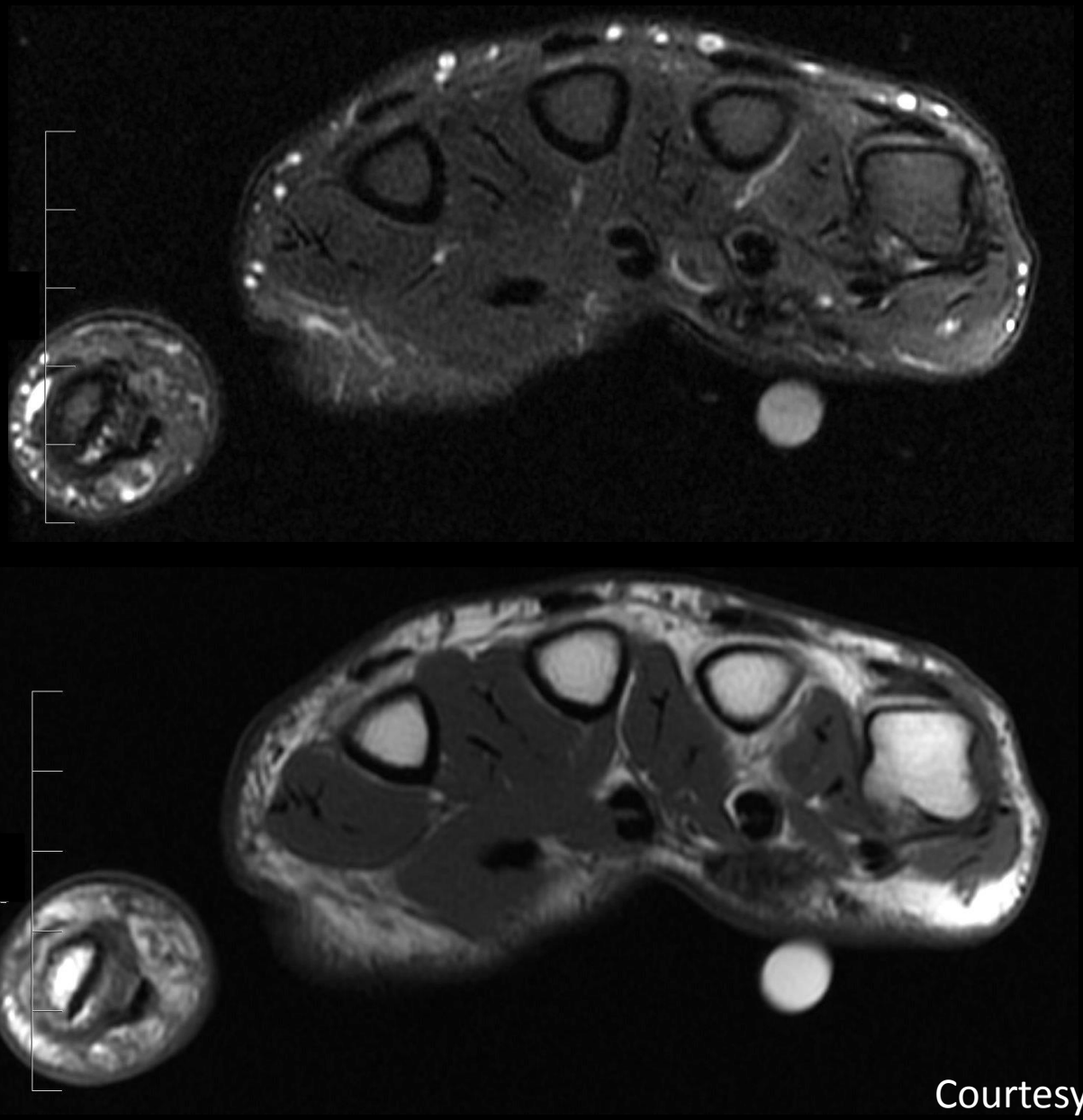
Upper extremity associations

Condition	Diabetes (prevalence, %)*	Nondiabetic (prevalence, %)*
Adhesive capsulitis	11-30%	2-10%
Limited joint mobility	8-50%	0-26%
Dupuytren's contracture	20-63%	13%
Carpal tunnel syndrome	11-16%	125/100,000 incidence
Flexor tenosynovitis	11%	<1%
DISH	13-49%	1.6-13%

- Common etiology of glycosylation of collagen
- Dependent on duration of diabetes

* Data from Australia. Smith LL, et al. Br J Sports Med 2003; 37:30-35.

Dupuytren’s contracture

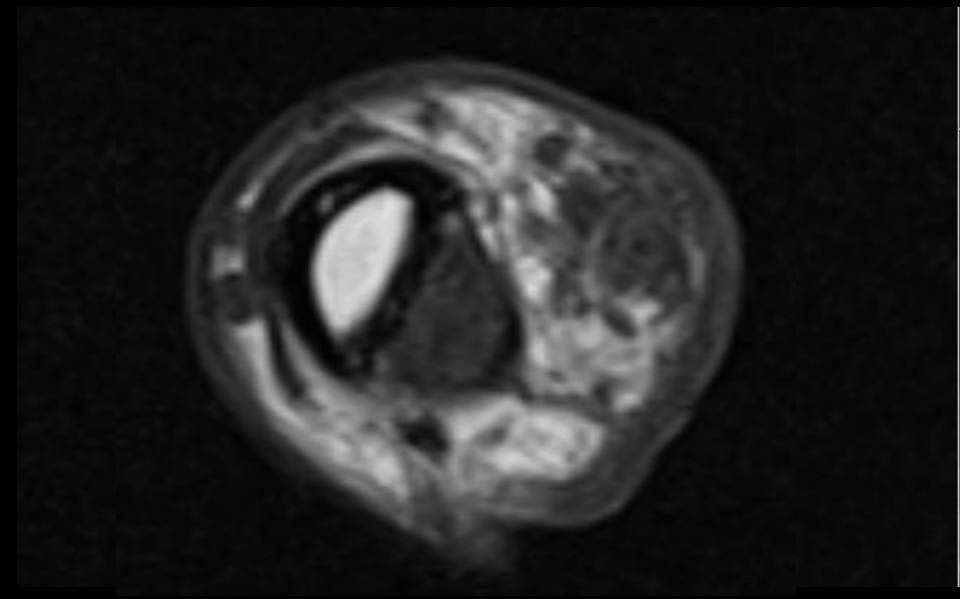


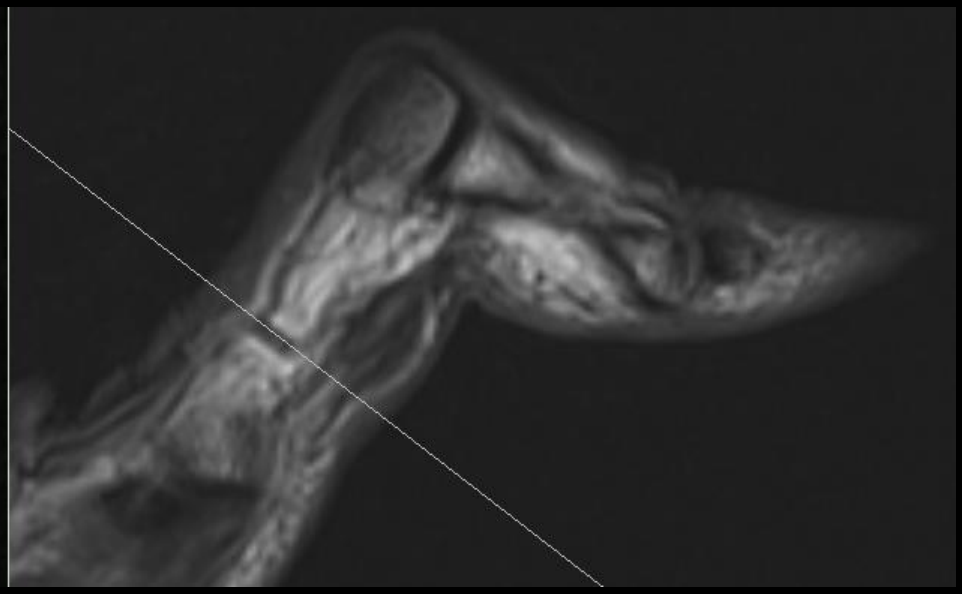
Courtesy of Mini Pathria

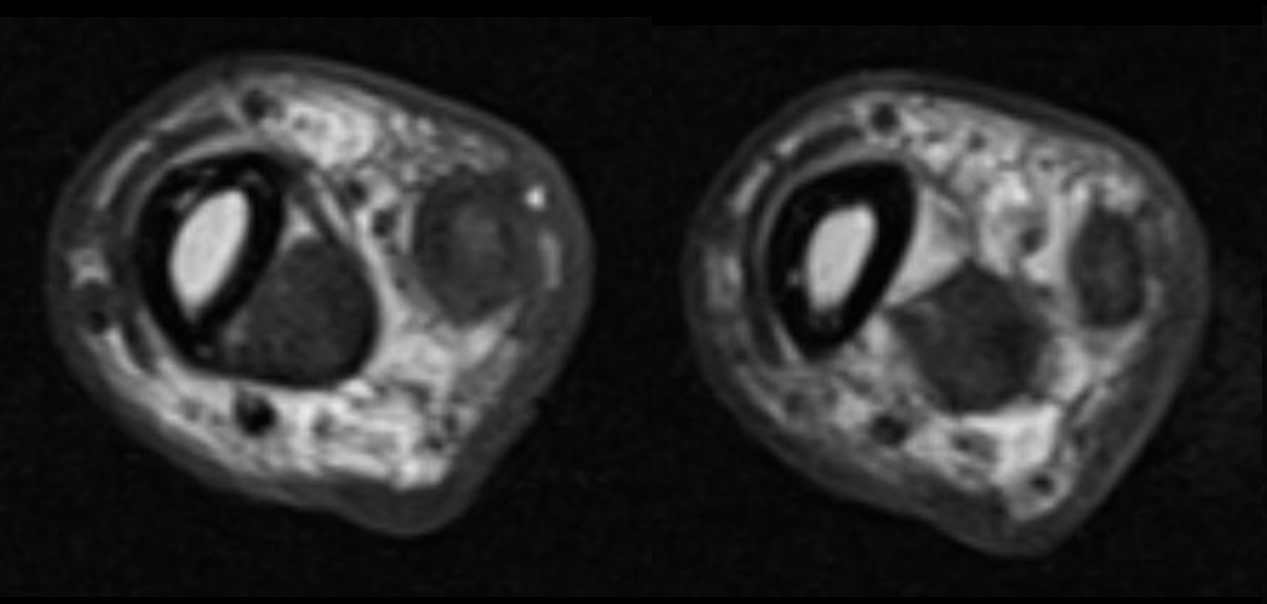
Dupuytren's contracture

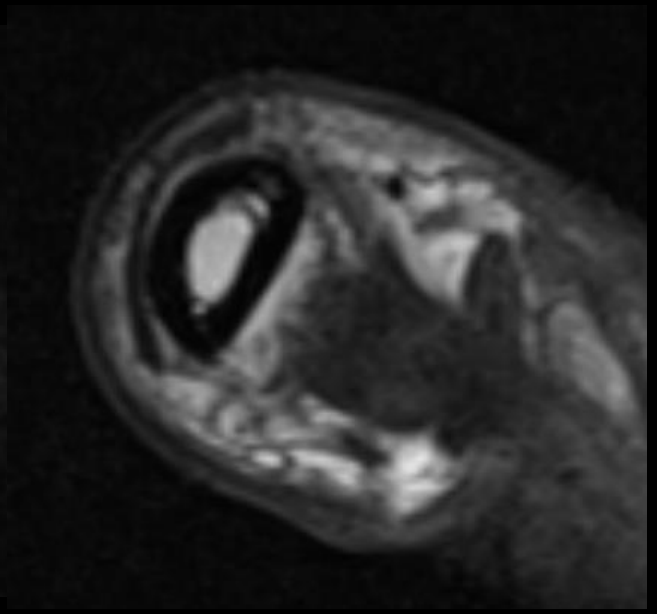
60 yo M w DM2, progressive contracture of 5th finger over 2 year period.

In patients with diabetes, the ring and middle finger are more commonly affected, compared with the fifth finger in patients without diabetes.

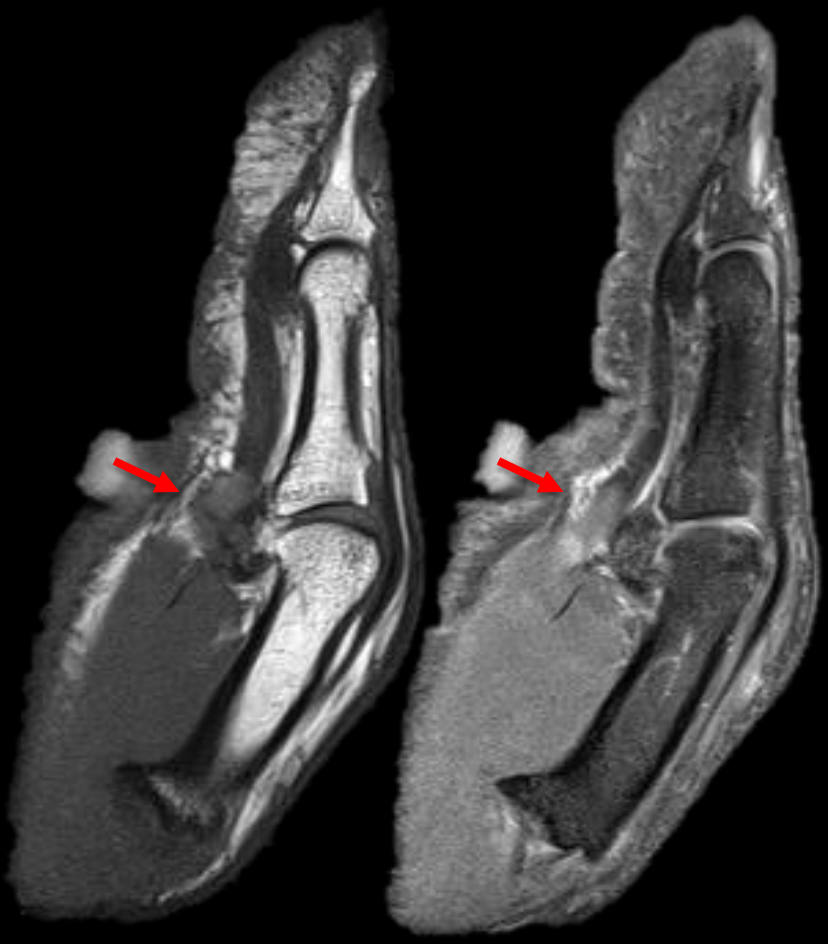








Flexor tenosynovitis



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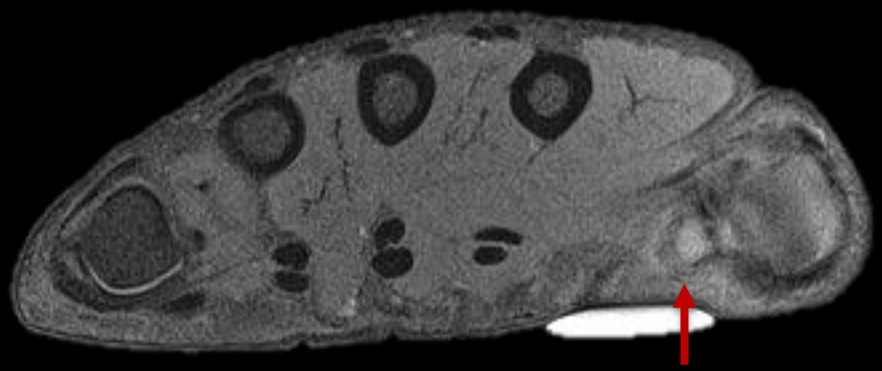
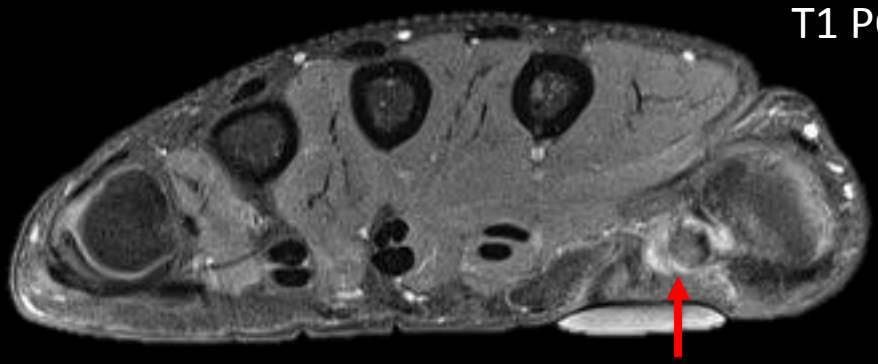


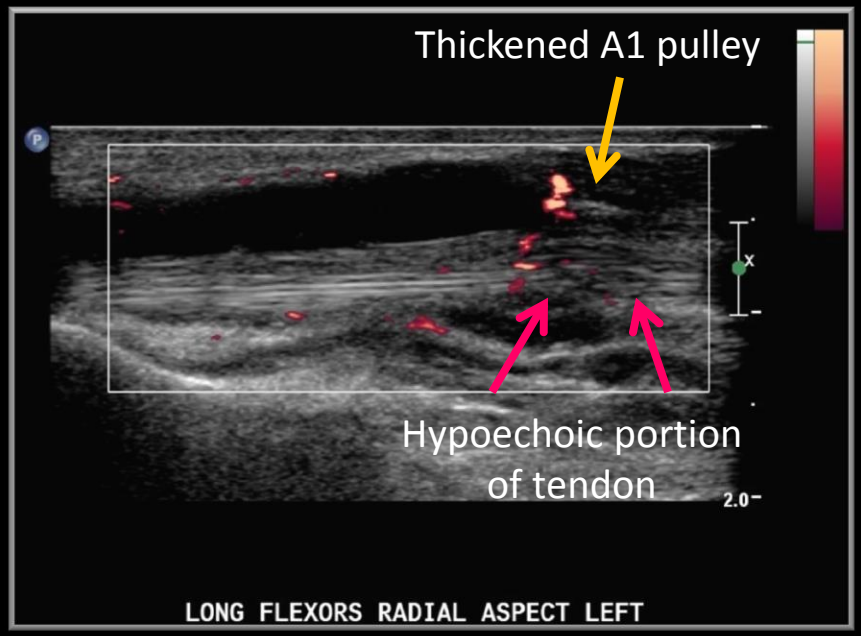
T1 POST

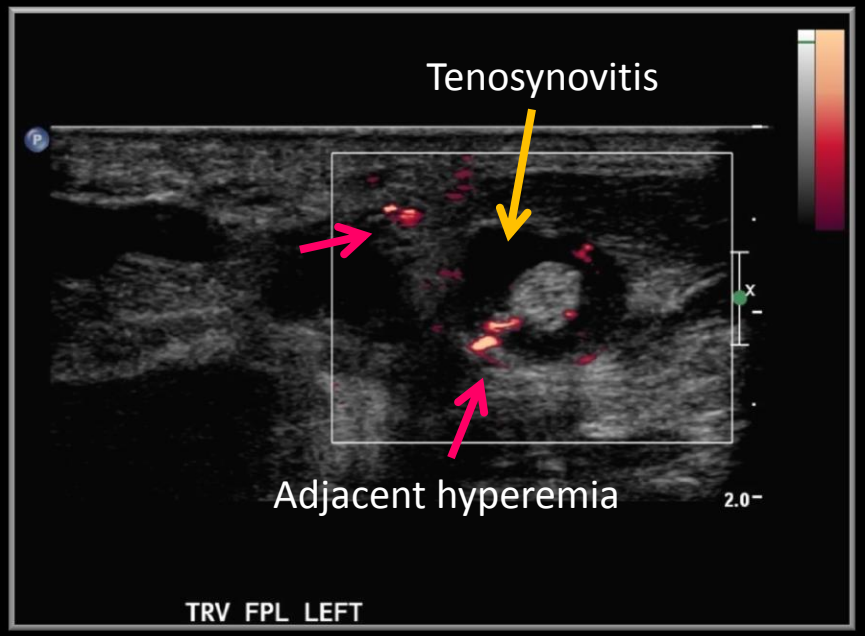


T1 PRE T1 FS POST

Courtesy of Tony Jeanemeane

Flexor Tenosynovitis





Musculoskeletal manifestations of diabetes

- Muscles
  - Diabetic myonecrosis
  - Infectious myositis
  - Denervation changes
- Foot
  - Ulcer
  - Osteomyelitis
  - Charcot neuroarthropathy
- Spine
  - Dialysis related spondyloarthropathy
  - Charcot spine
- Associations
  - Calcaneal insufficiency avulsion fracture
  - Dialysis-related amyloidosis
  - Adhesive capsulitis
  - Dupuytren’s contracture
  - Flexor tenosynovitis
  - Carpal tunnel syndrome

July 2014:
Eat your vegetables...

May 2015:
or crayons.

THANK YOU

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