

Musculoskeletal Infection

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ACR Education Center: MSK Specialized Topics



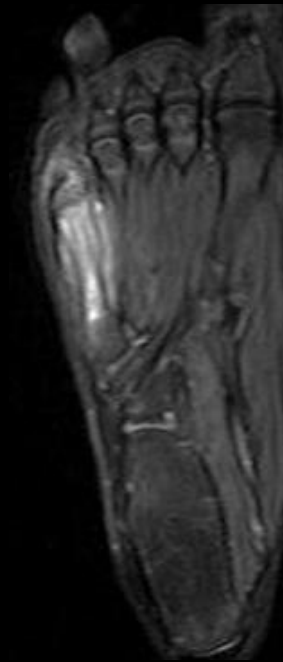
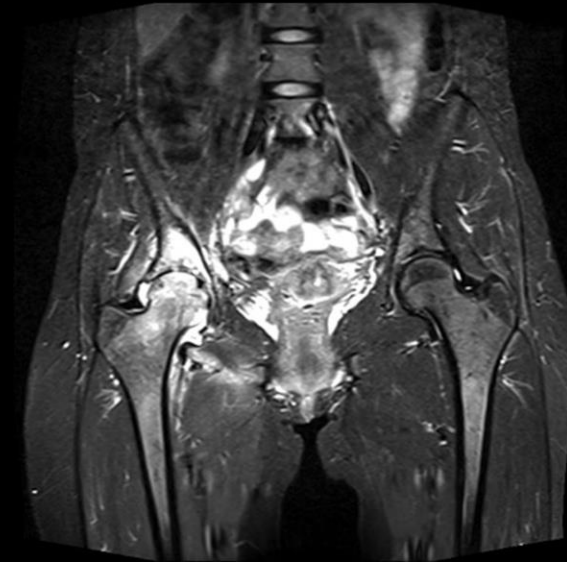
Infection

- Considerations
 - Age – different distribution
 - Mode of spread
 - Location
 - Pelvis, foot: contiguous spread
 - Knee: post-op
 - Metaphysis: Hematogenous
 - Bug
 - Common agents: typical imaging
 - Atypical patterns
 - Unusual organisms
 - Chronic osteomyelitis
 - Devitalized tissue

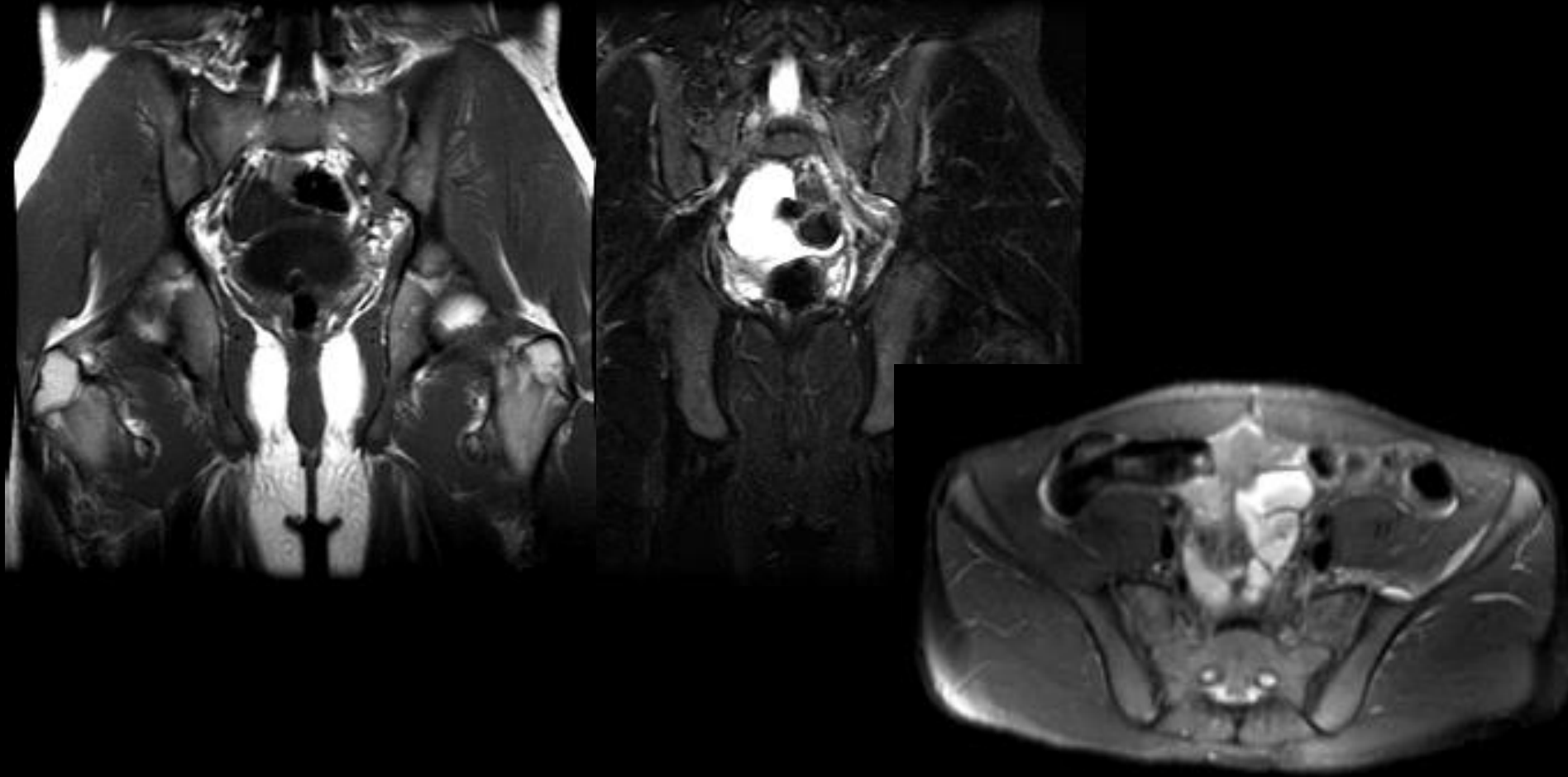


Modes

- Hematogenous
 - Pediatric
- Contiguous spread
 - Paralyzed patients – pelvis
 - Diabetic patients – foot/ankle
- Direct implantation
 - Esp foot, post-op

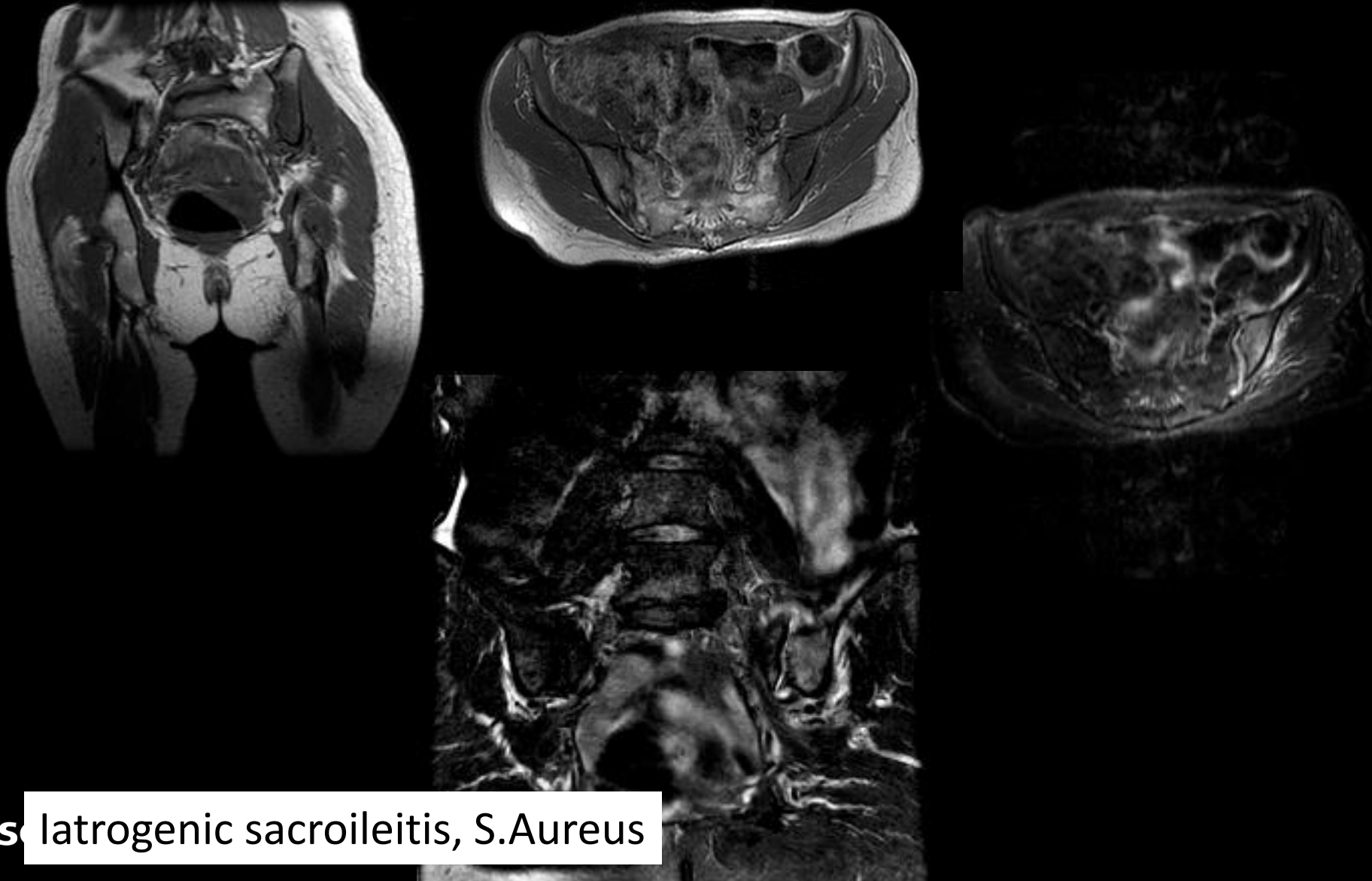


15 year old wrestler with LLE pain and weakness 10 days
after starting antibiotics for impetigo

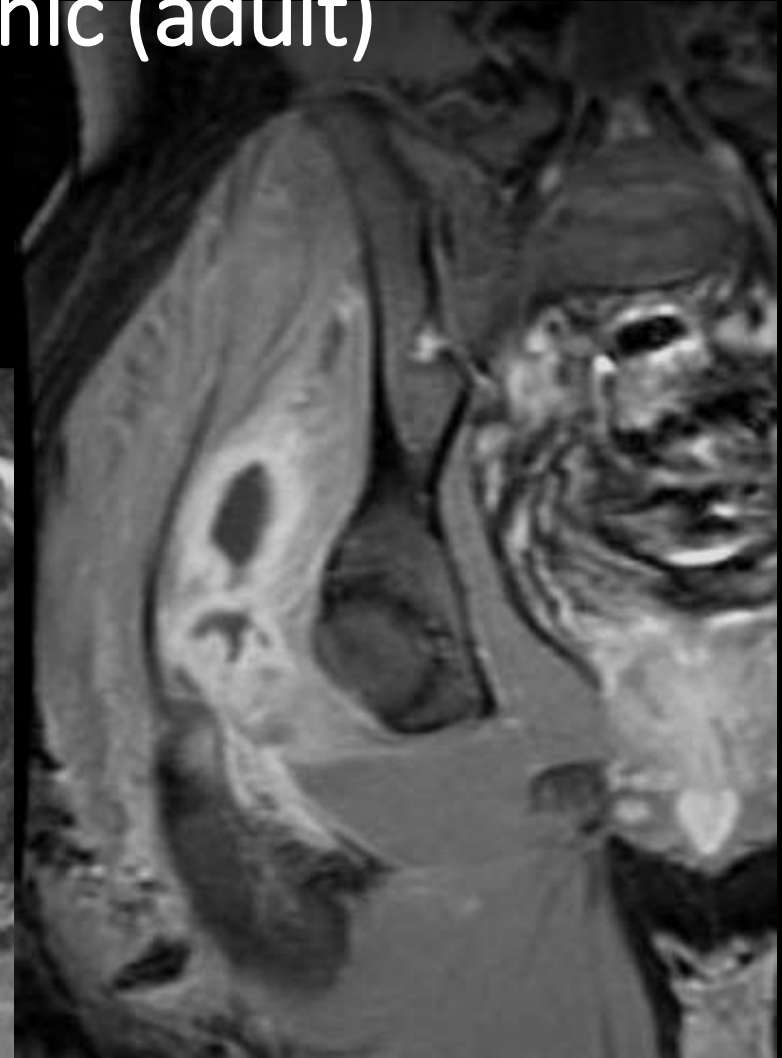
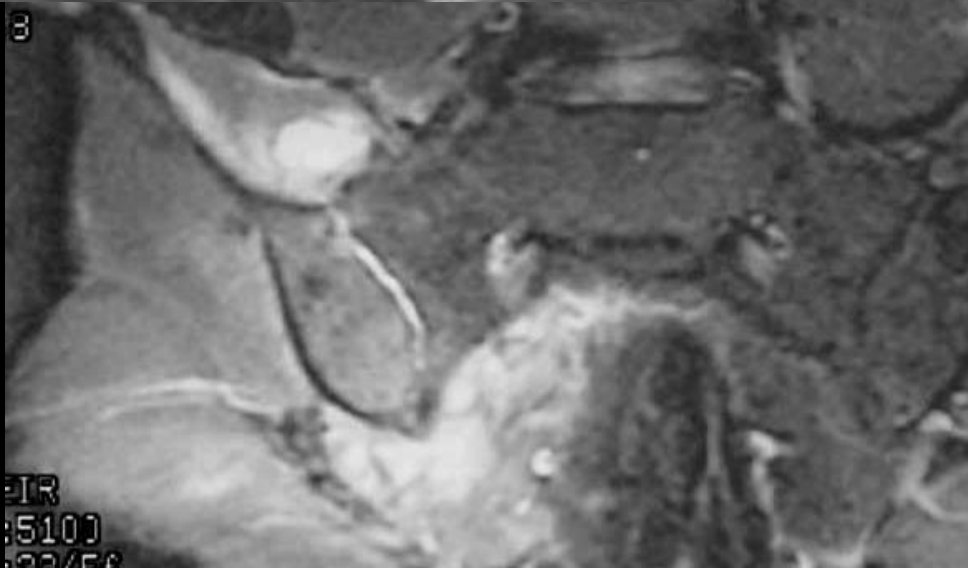
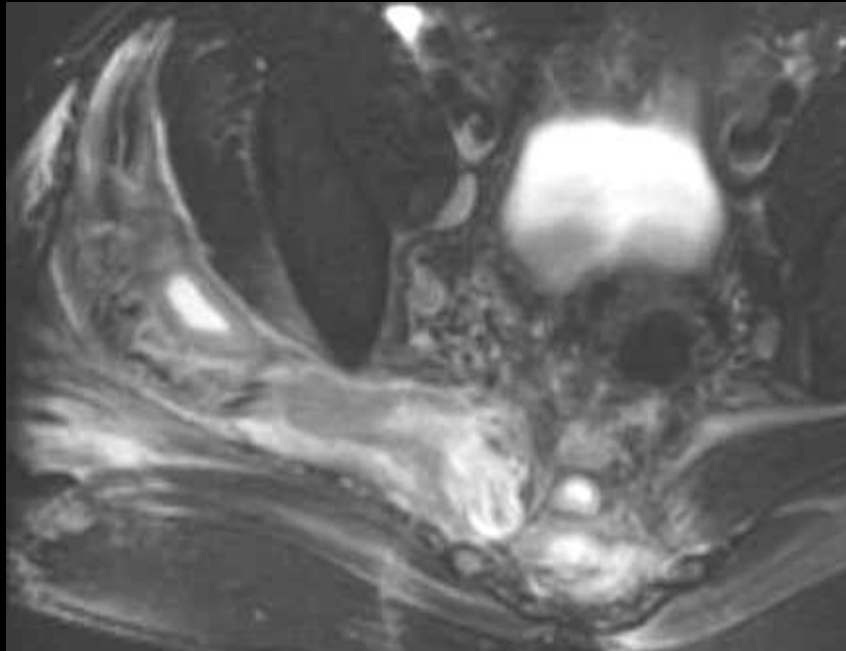


Hematogenous septic SI, grew Strep Pyogenes

Worsening LLE pain 3 weeks after “therapeutic L SI joint injection”



Septic Sacroiliitis: hematogenous (young) vs. iatrogenic (adult)



Septic Arthritis

- **Plain radiographs**
 - Joint space narrowing
 - Juxta-articular osteopenia/erosions
- **MR imaging**
 - Effusion
 - Thick synovial enhancement
 - Subchondral edema / enhancement
 - If thin = reactive
 - Marginal destruction



Radiographs



Loss of cortical "white line"

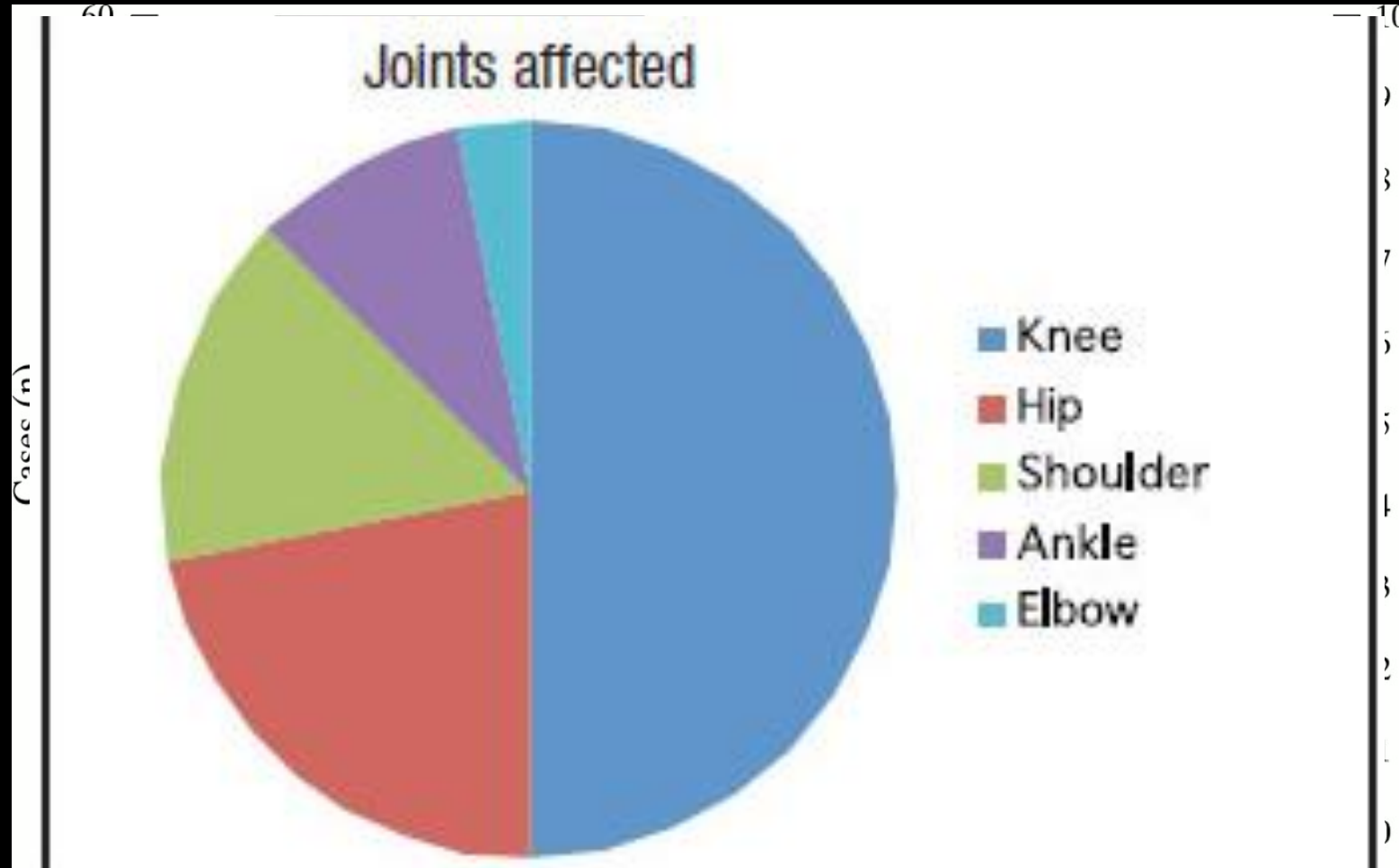


Periosteal reaction

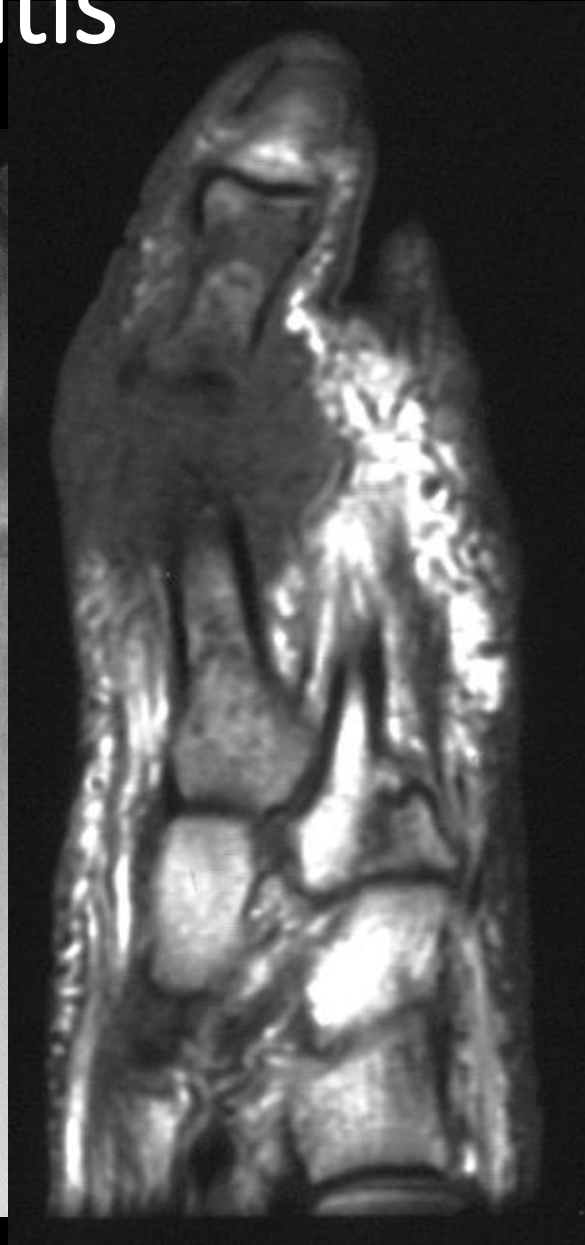


Soft tissue defect

Septic Arthritis distribution by age



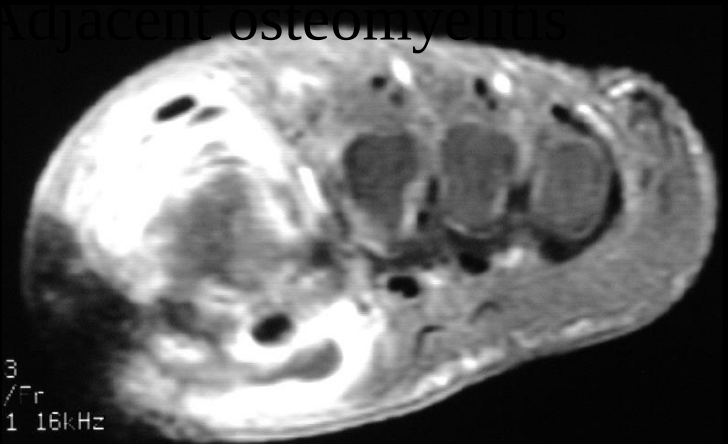
Septic Arthritis



-Effusion / soft tissue swelling

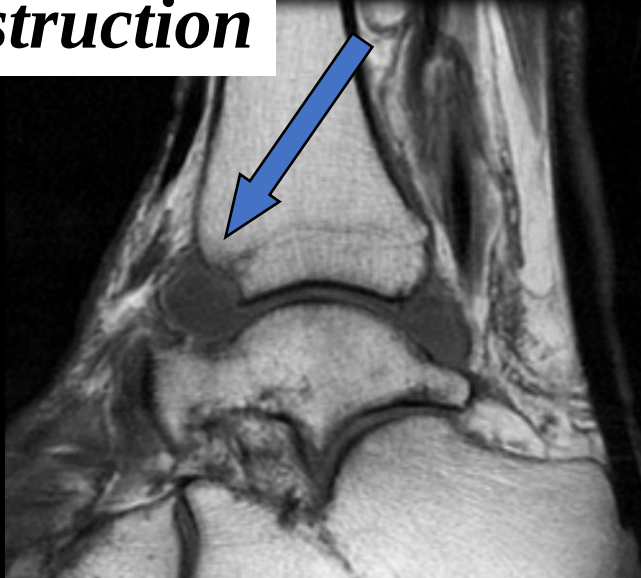
-Cortical destruction

-Adjacent osteomyelitis

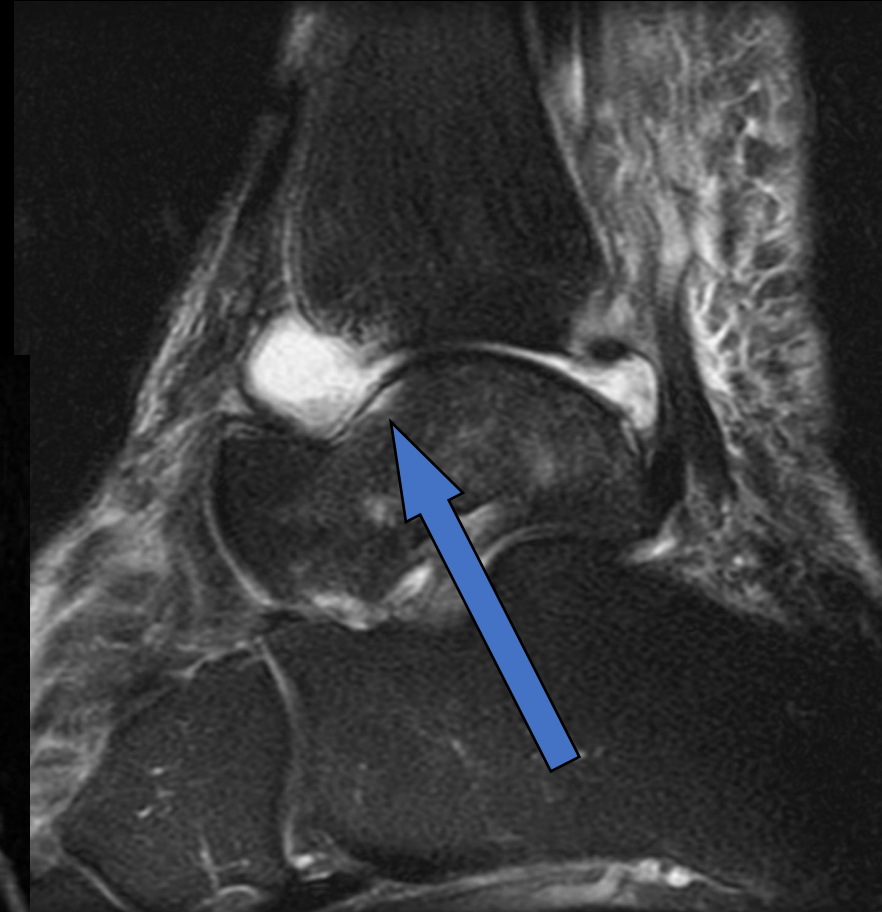
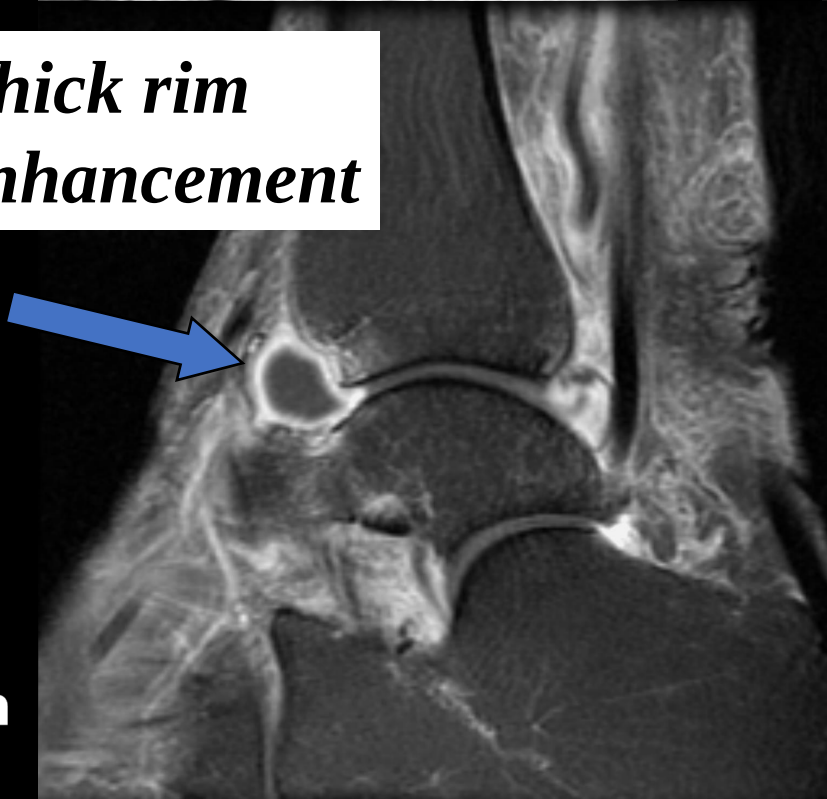


Septic Arthritis

destruction

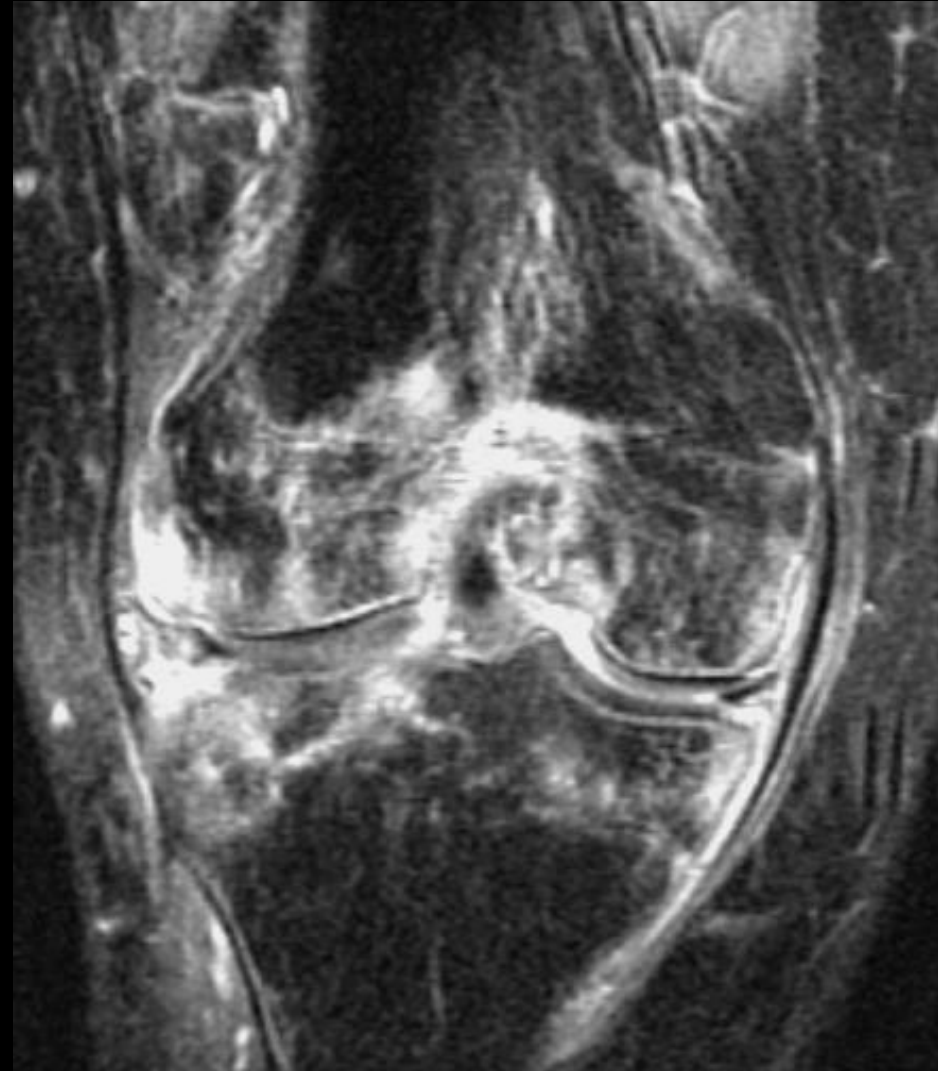
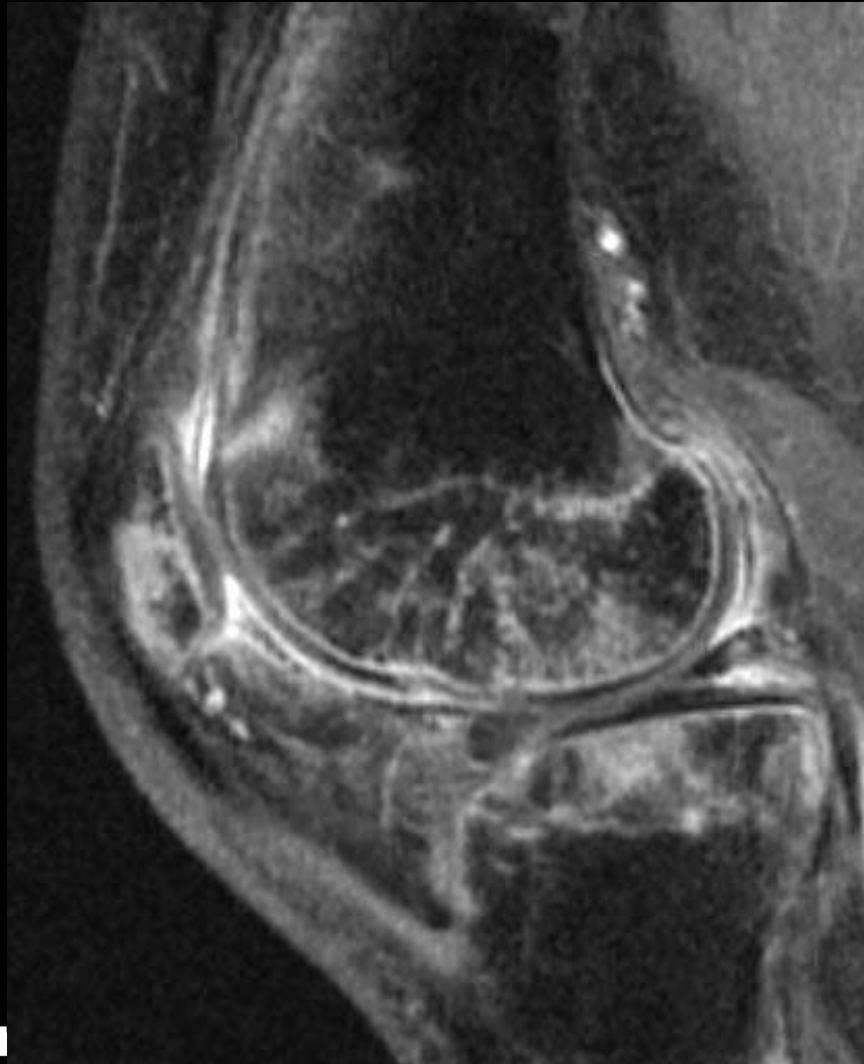


Thick rim enhancement

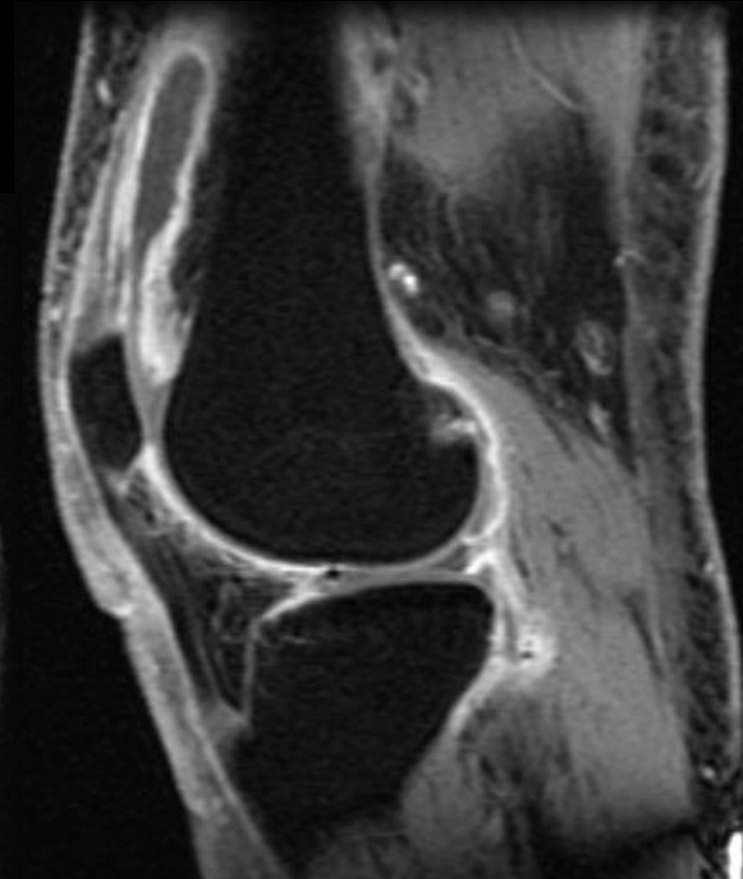
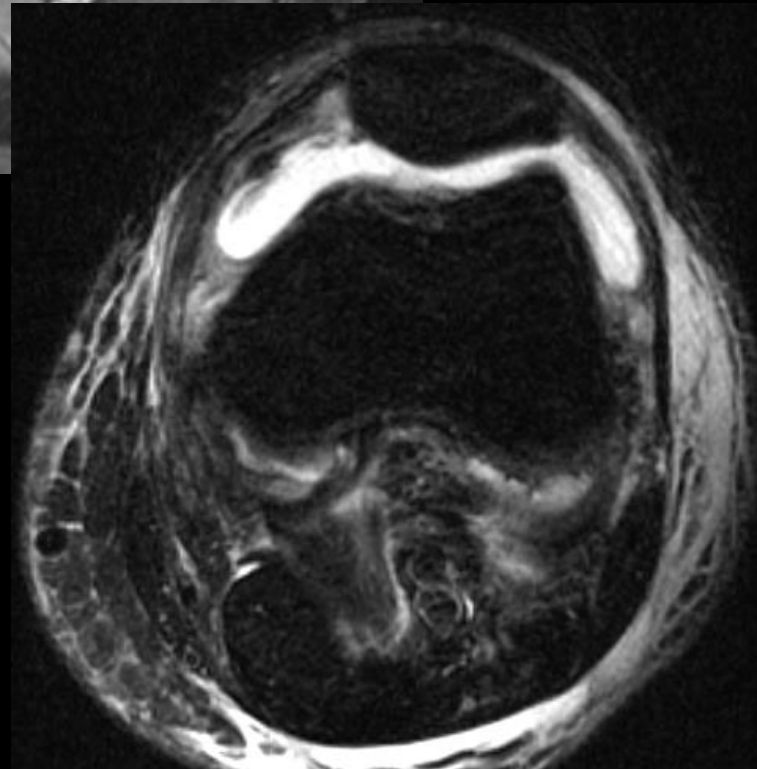
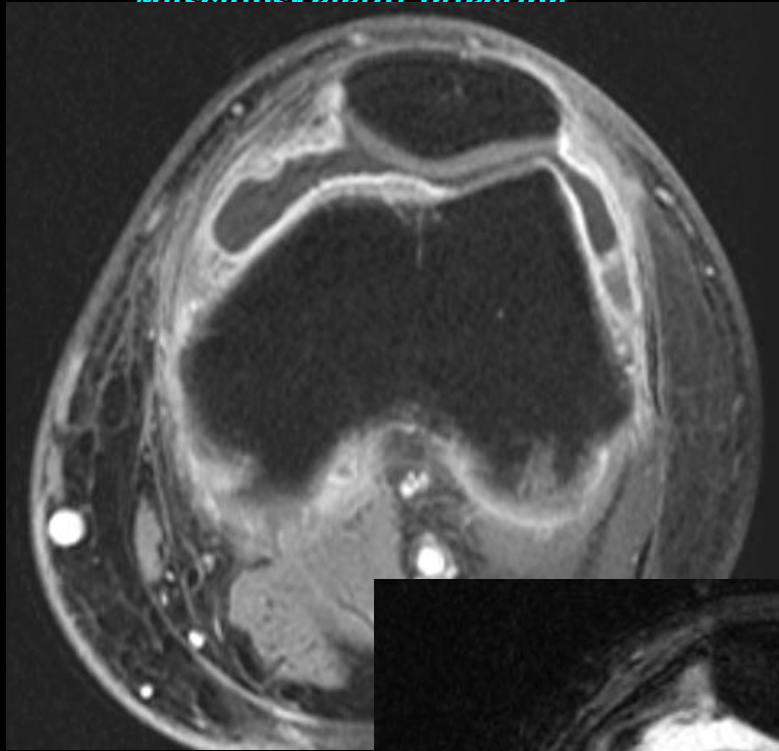


Subchondral edema

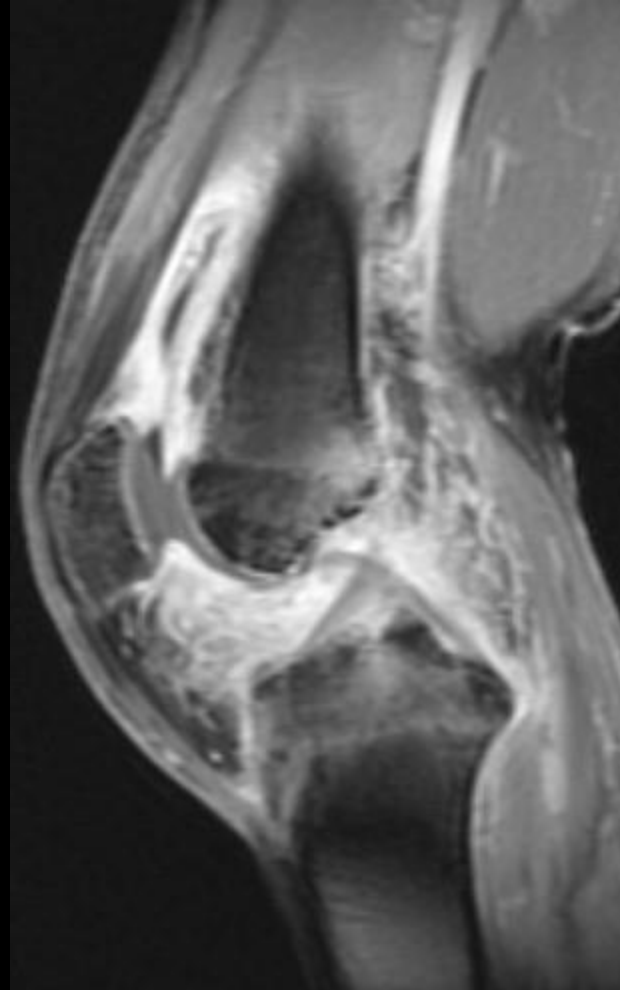
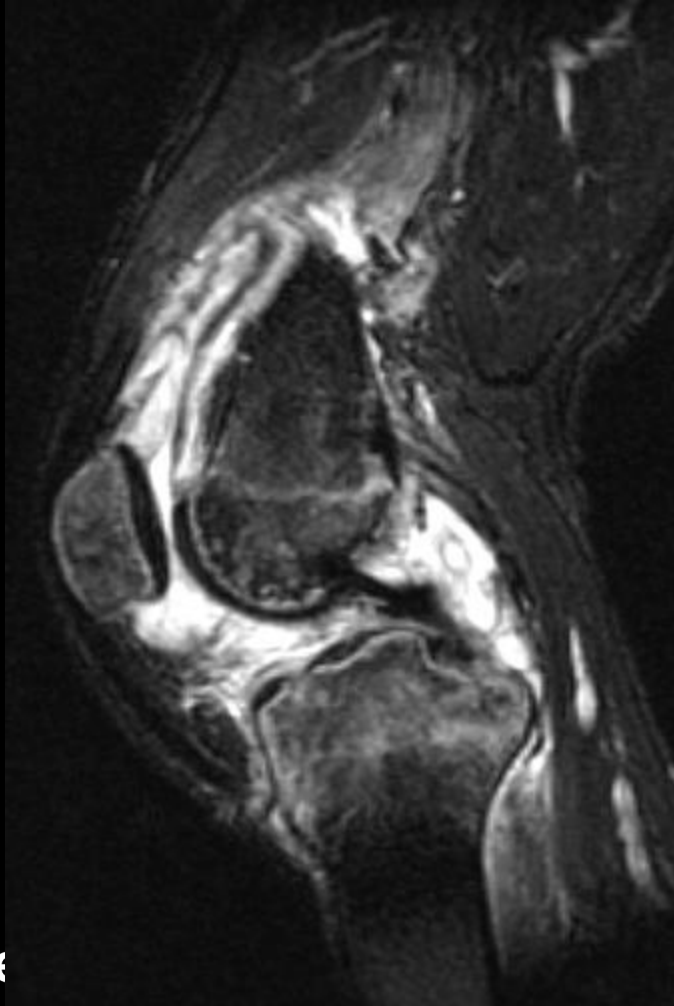
Septic Arthritis: noncontrast



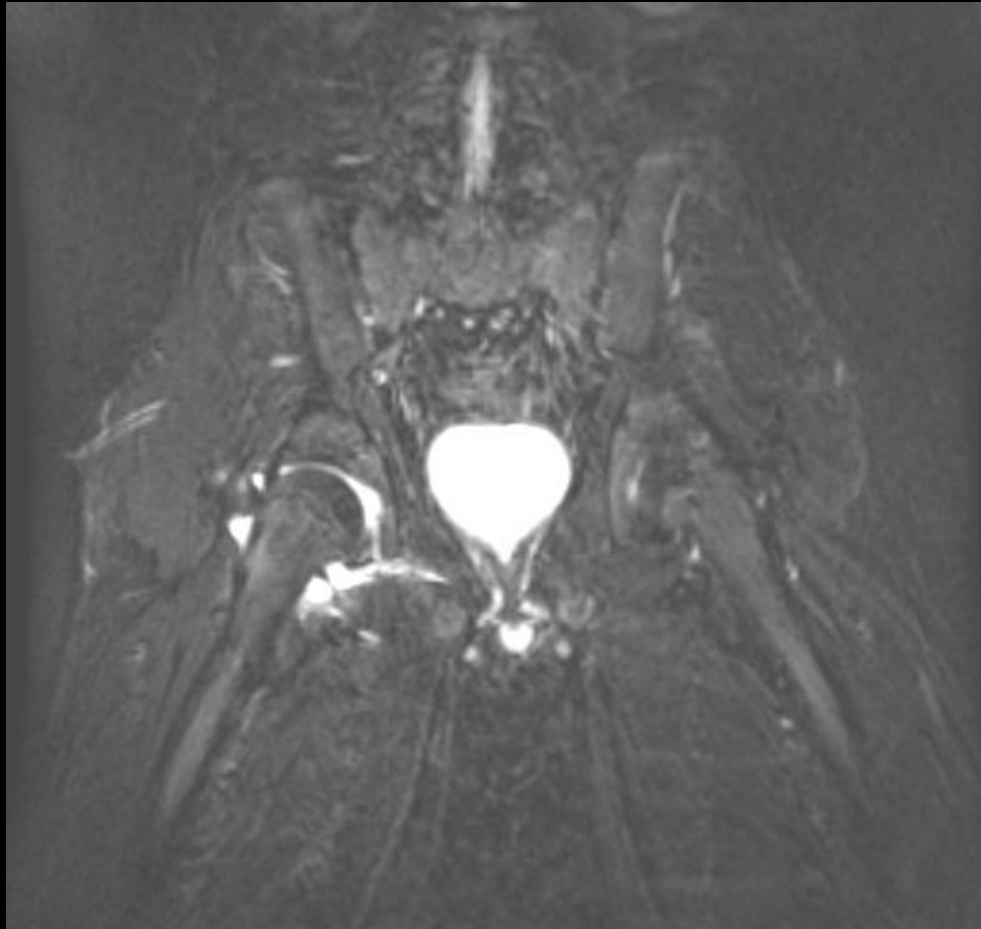
Septic Arthritis S. Aureus



Septic Arthritis: IV Contrast



Pediatric Septic Arthritis

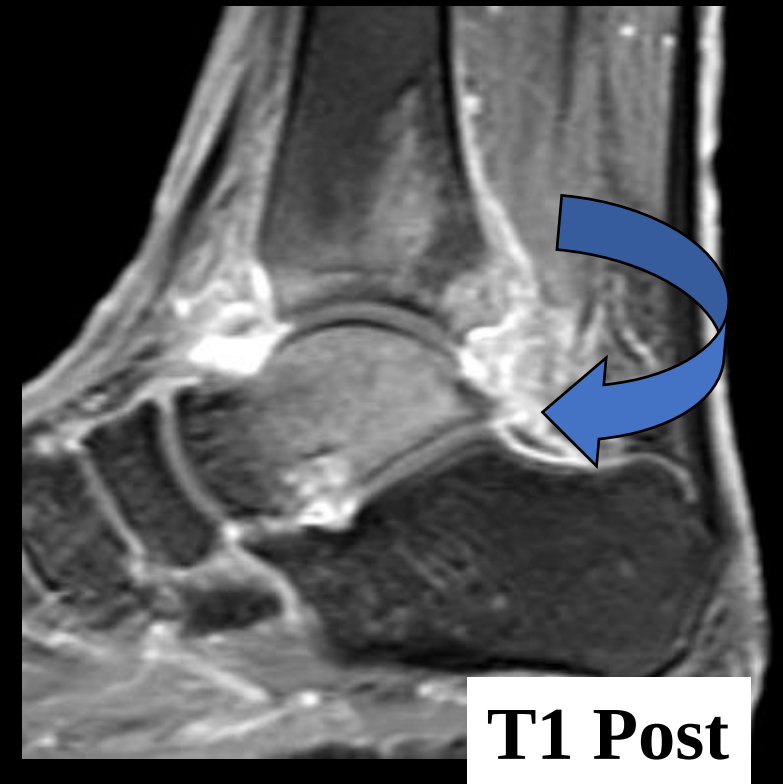


Septic Arthritis

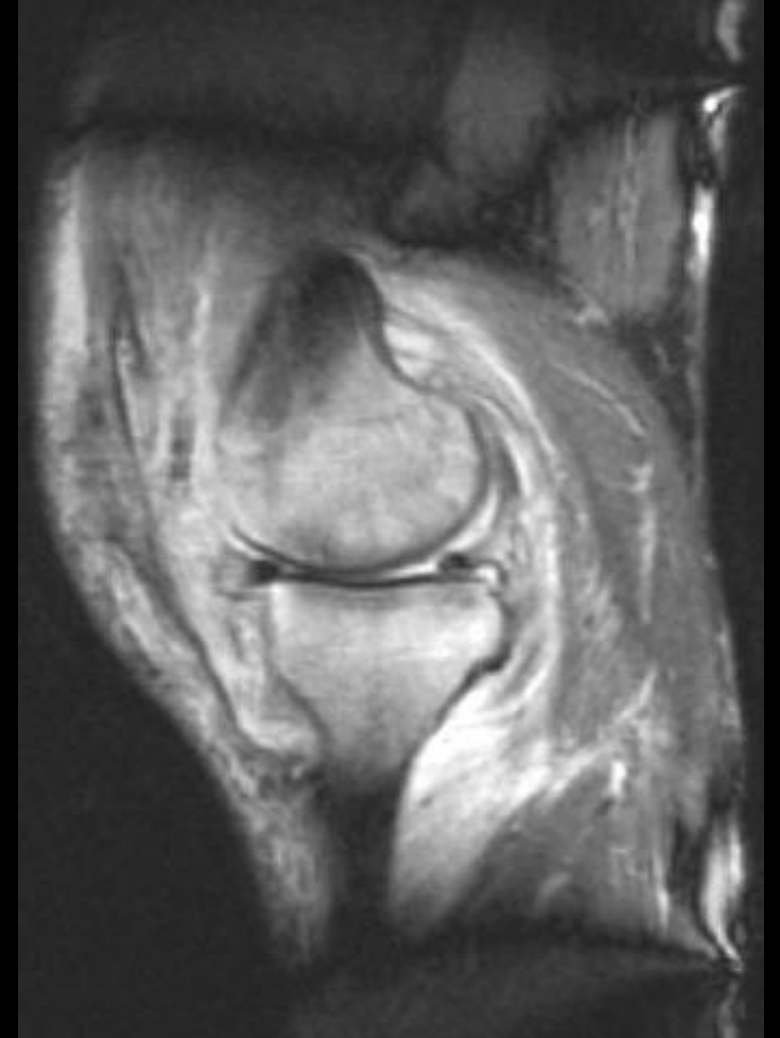
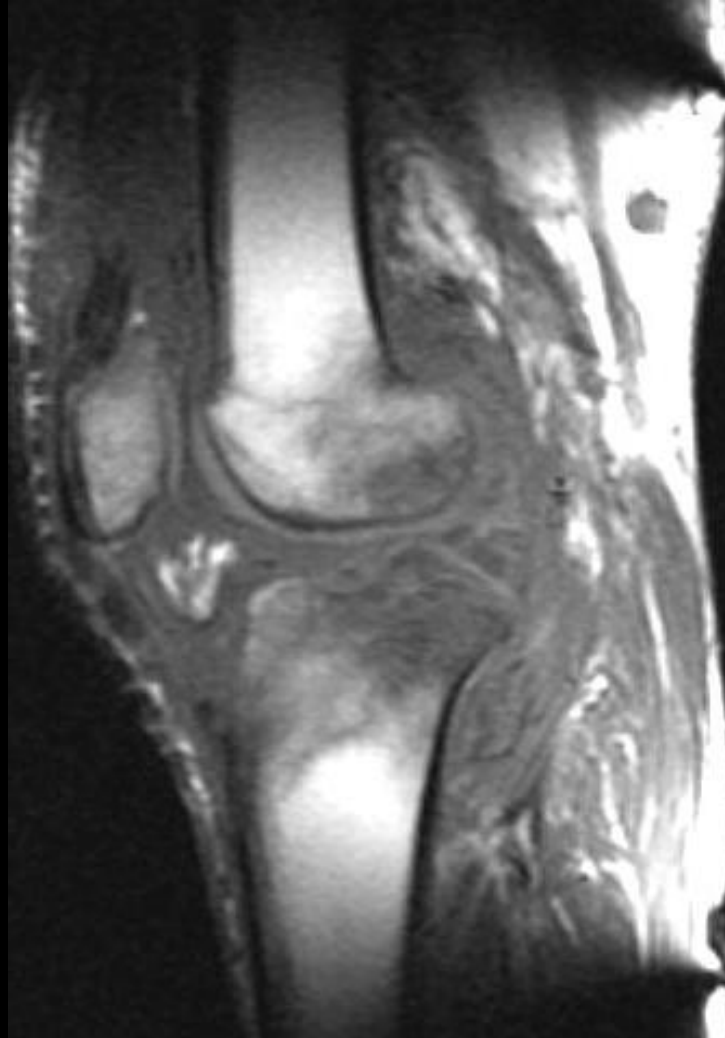
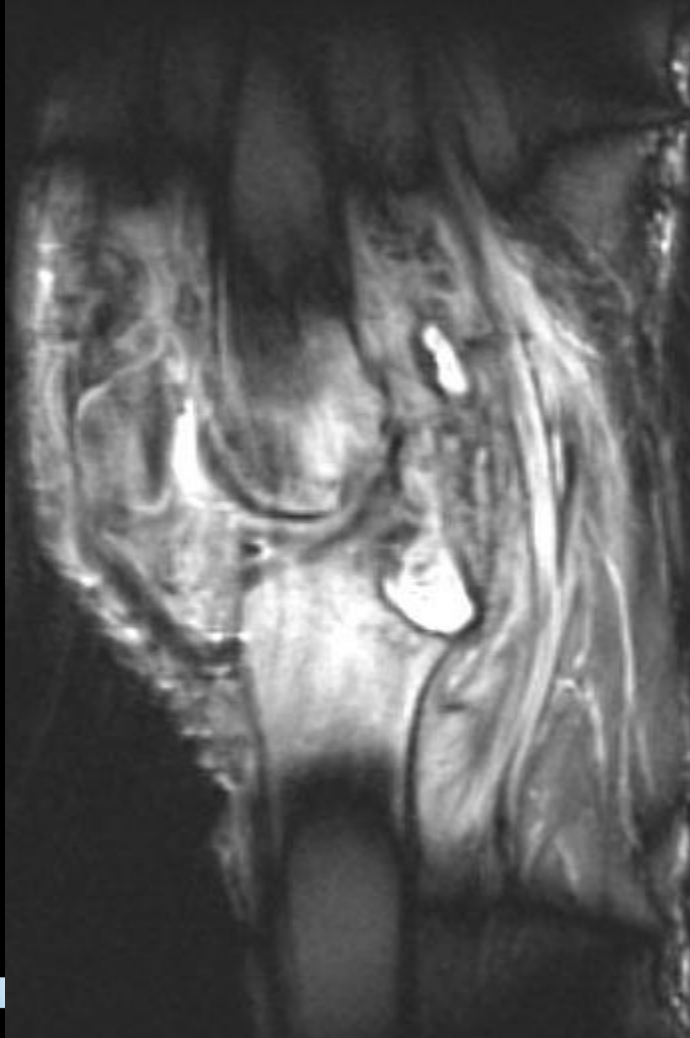
- DDx inflammatory arthropathy (e.g., RA)
- If subchondral BME / enhancement extends into medullary cavity, suspect osteomyelitis



Septic Arthritis Osteomyelitis

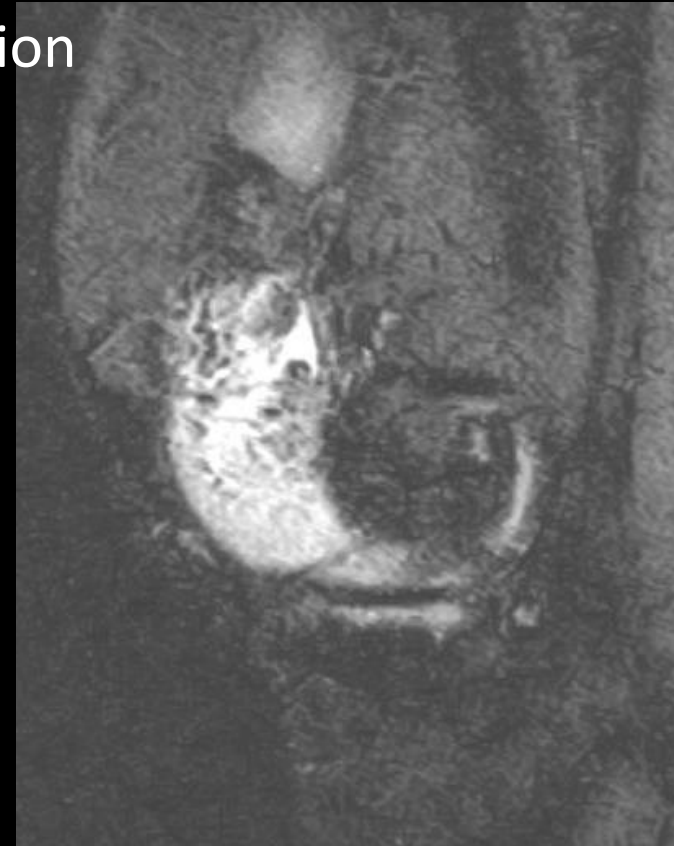


Septic arthritis - osteomyelitis



Synovial Proliferation

- Wide DDx
 - Inflammatory arthropathy (e.g., RA)
 - Infection
 - Non-inflammatory synovial proliferation
 - PVNS
 - Synovial osteochondromatosis
 - Surgery
 - Hemorrhage

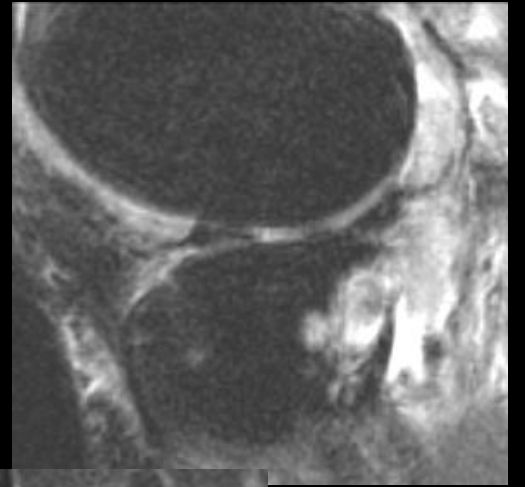


“Dirty fluid”

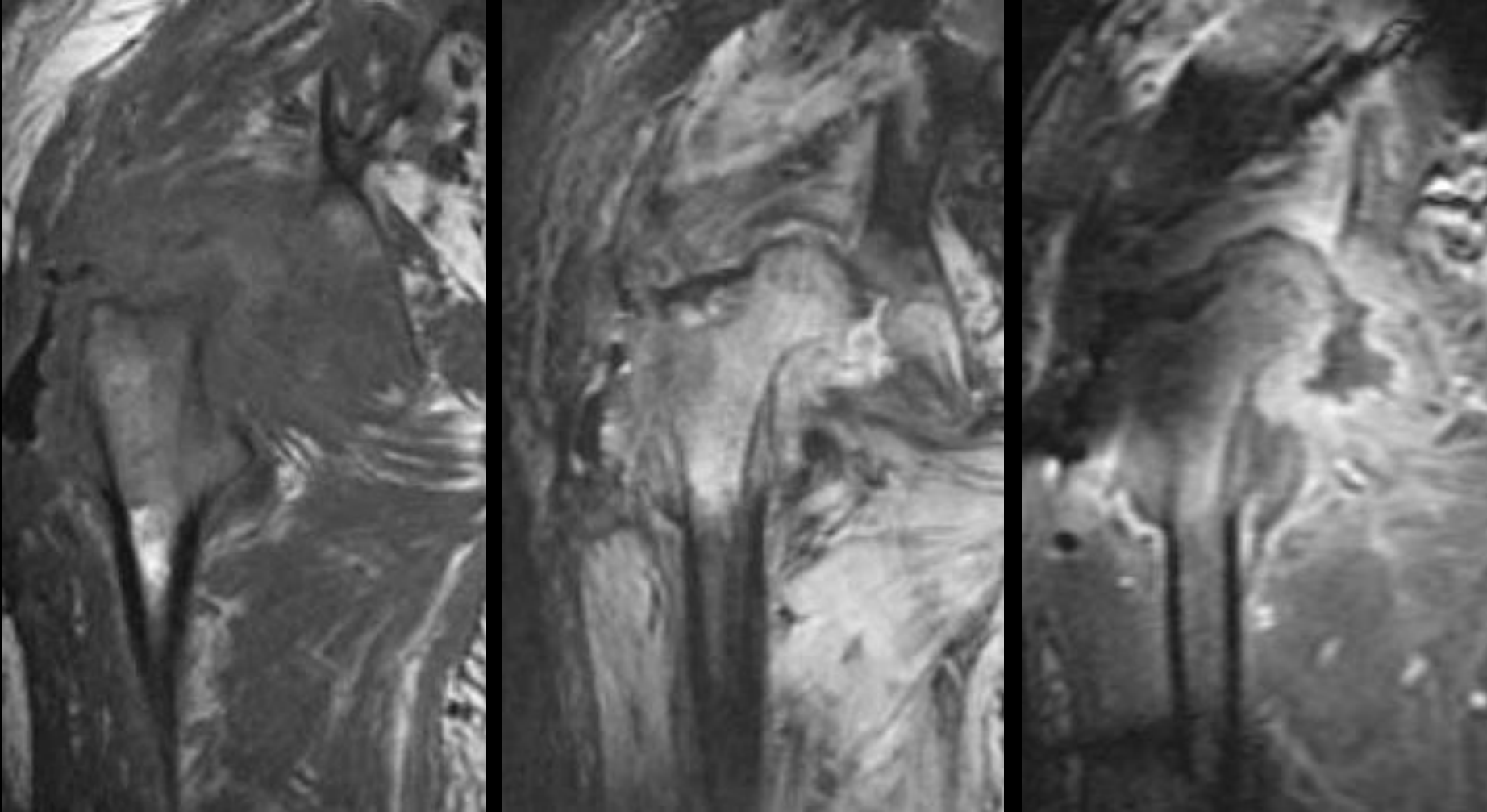
Inflammatory Arthropathy

Rheumatoid arthritis

-synovial pannus, +/- erosions (large joint capacity)



Septic Arthritis / Osteomyelitis



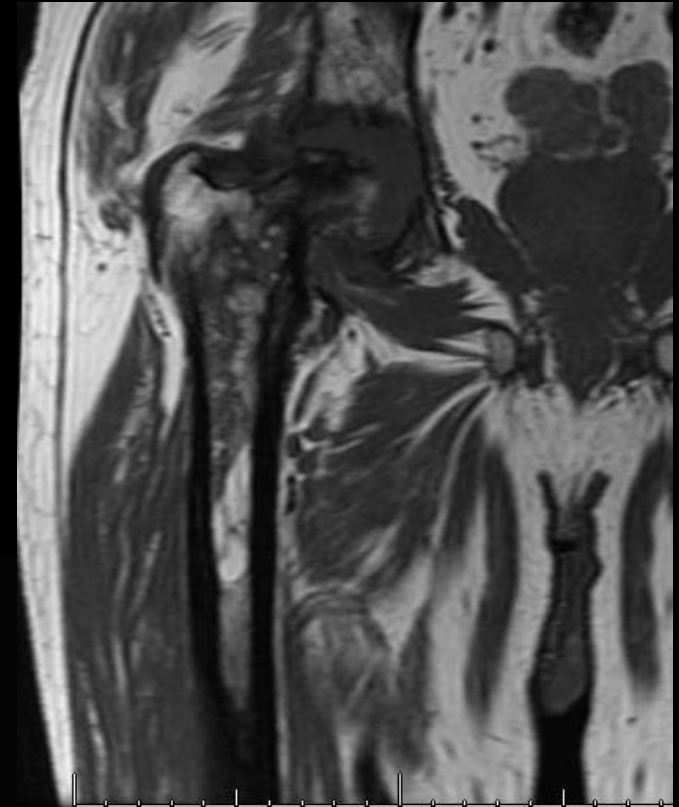
Osteomyelitis



Cortical destruction



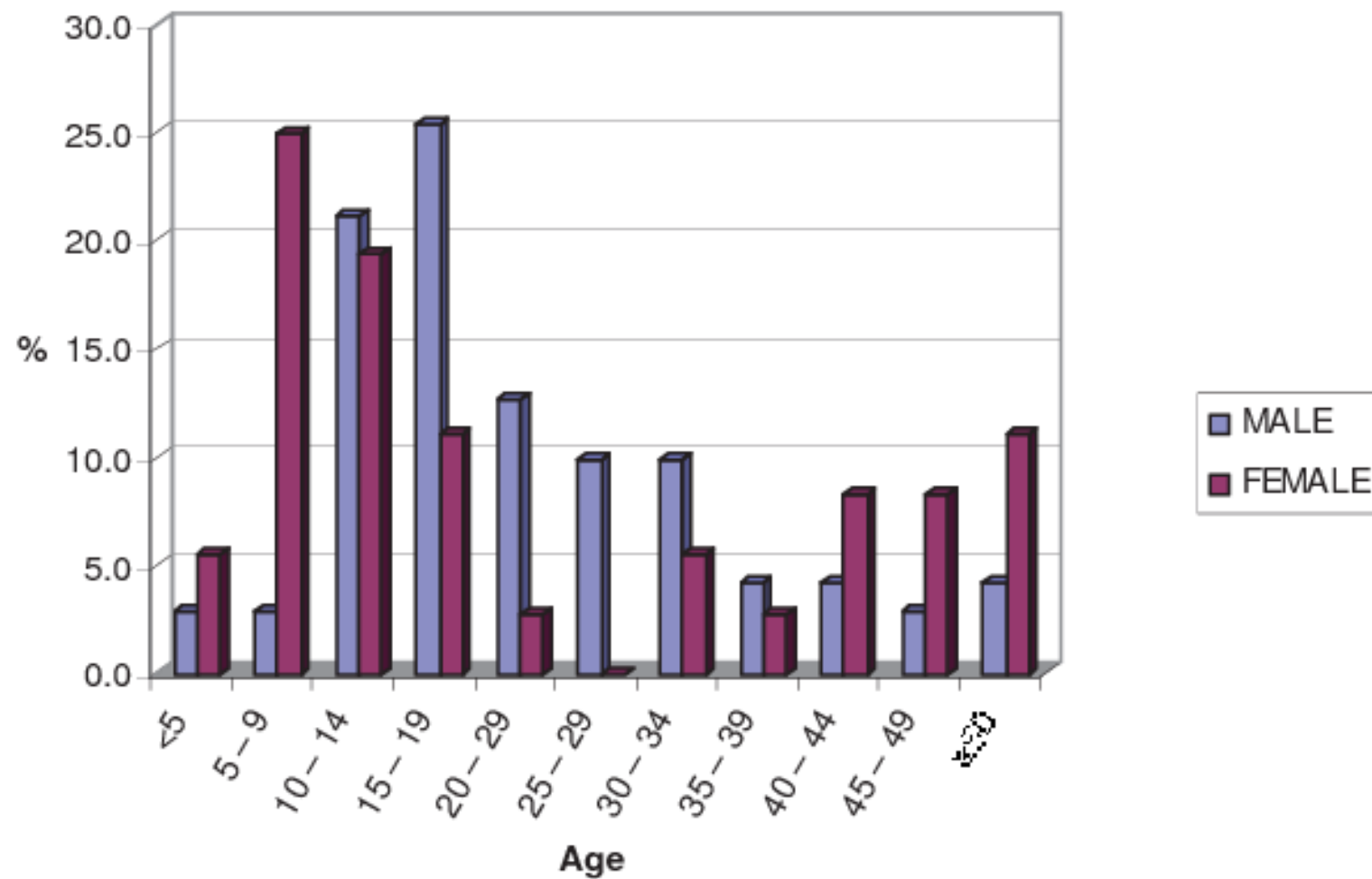
Periosteal reaction



T1 Marrow replacement

Osteomyelitis by age

Age and Sex Distribution



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REVIEW ARTICLE



MRI nomenclature for musculoskeletal infection

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Abstract

The Society of Skeletal Radiology (SSR) Practice Guidelines and Technical Standards Committee identified musculoskeletal infection as a White Paper topic, and selected a Committee, tasked with developing a consensus on nomenclature for MRI of musculoskeletal infection outside the spine. The objective of the White Paper was to critically assess the literature and propose standardized terminology for imaging findings of infection on MRI, in order to improve both communication with clinical colleagues and patient care.

A definition was proposed for each term; debate followed, and the committee reached consensus. Potential controversies were raised, with formulated recommendations. The committee arrived at consensus definitions for cellulitis, soft tissue abscess, and necrotizing infection, while discouraging the nonspecific term phlegmon. For bone infection, the term osteitis is not useful; the panel recommends using terms that describe the likelihood of osteomyelitis in cases where definitive signal changes are lacking. The work was presented virtually to SSR members, who had the opportunity for review and modification prior to submission for publication.

Keywords MRI · Musculoskeletal infection · Osteomyelitis · Abscess

Society of Skeletal Radiology White Paper 2022

Table 1 Summary of terms assigned to each category

Category	Assigned terms
Soft tissue 1	Edema, cellulitis, ulcer, cloaca, sinus tract
Soft tissue 2	Soft tissue abscess, phlegmon, devitalized tissue, necrotizing fasciitis
Joints/tendon sheaths	Septic arthritis, synovitis, septic/infectious tenosynovitis, and erosion
Bone surface	Periostitis, periosteal reaction, periosteal new bone formation, subperiosteal abscess, cortical breakthrough
Medullary space	Osteomyelitis, osteitis, intra-osseous abscess
Necrosis	Sequestrum, involucrum

Table 2 (continued)

Current term	Definition	Controversy and rationale	Recommendations
Cloaca	Opening or rupture of bone cortex overlying an area of osteomyelitis, allowing discharge of granulation tissue, pus, or necrotic bone	- Remnant of reparative callus may persist within the cortex after the infection has cleared - Should be differentiated from pathologic fracture and erosion	- Cloaca should be used for an opening or rupture of cortex overlying an area of osteomyelitis - Pathologic fracture should be used when there is a delineated fracture cleft resulting from weakened bone undergoing minimal stress - The nonspecific term cortical breakthrough is discouraged but may be used when the etiology is unclear - Consider repeat MRI to identify intraosseous fluid collections deep to the cloaca as an indicator of persistent infection Recommended term: cloaca
Medullary space			
Osteomyelitis	Infection of bone which involves the medullary canal	- Discordant marrow signal - Concomitant trauma, neoplasia, arthropathies, or osteonecrosis - Marrow signal abnormality in neuropathic arthritis difficult to differentiate from osteomyelitis - Vascular insufficiency may fail to produce T1 marrow replacement, enhancement	- Osteomyelitis is recommended when concordant marrow signal changes are present - “Osteitis” and “reactive marrow edema” should be avoided in infection, but still apply in non-infection cases like those due to inflammatory arthritis - “High likelihood of osteomyelitis” is recommended for any hyperintense marrow signal on fluid-sensitive images (regardless of T1 signal) adjacent to an ulcer, abscess, or sinus tract - Chronic osteomyelitis should be used if the marrow demonstrates patchy areas of active disease and fibrosis, especially with features such as cortical remodeling, Brodie’s abscess, sequestrum, or sinus tract - Infected, devitalized bone may be appropriate when there are findings diagnostic of osteomyelitis without contrast enhancement Recommended terms: osteomyelitis, “high or low likelihood of osteomyelitis,” chronic osteomyelitis, infected-nonviable bone
Intraosseous abscess	Intraosseous cavity filled with pus, with rim of granulation tissue	- May be difficult to differentiate between intraosseous abscess and neoplasia	- Intraosseous abscess is appropriate for intraosseous fluid-signal cavities with a rim of peripheral enhancement, or in the presence of restricted diffusion or the penumbra sign if contrast not administered - Brodie’s abscess should be used for intraosseous abscesses in subacute or chronic osteomyelitis having a predilection for the ends of tubular bones Recommended terms: intraosseous abscess, Brodie’s abscess



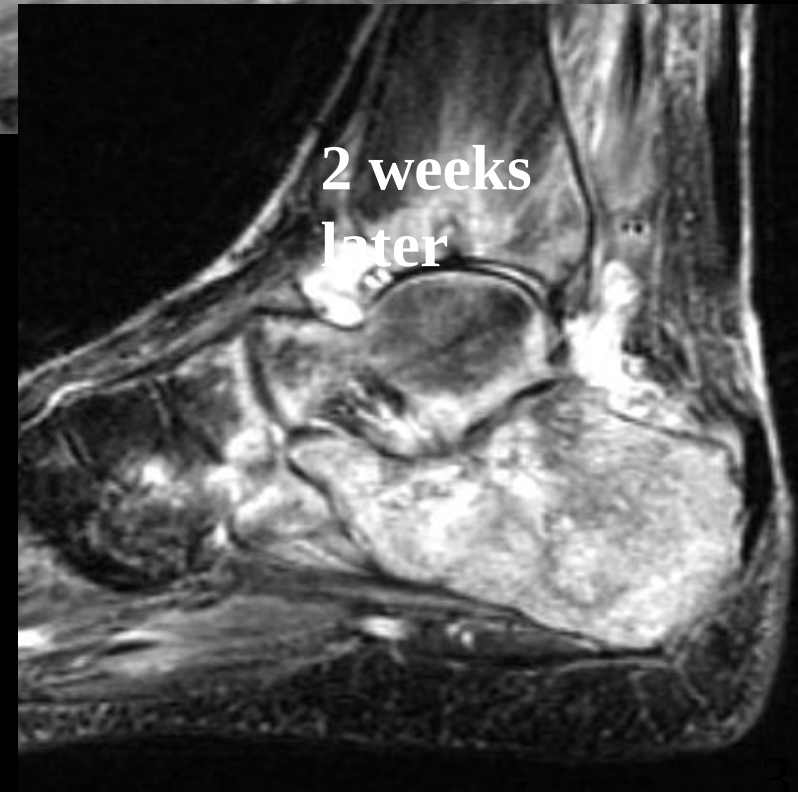
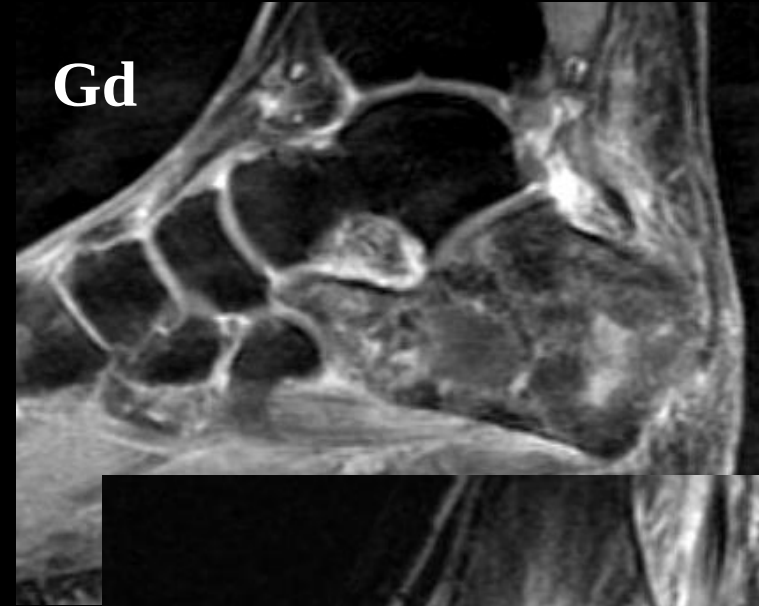
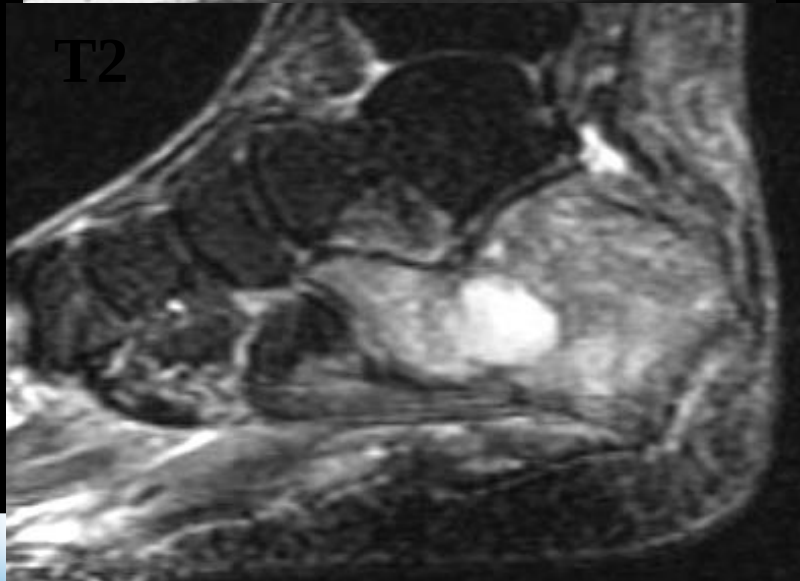
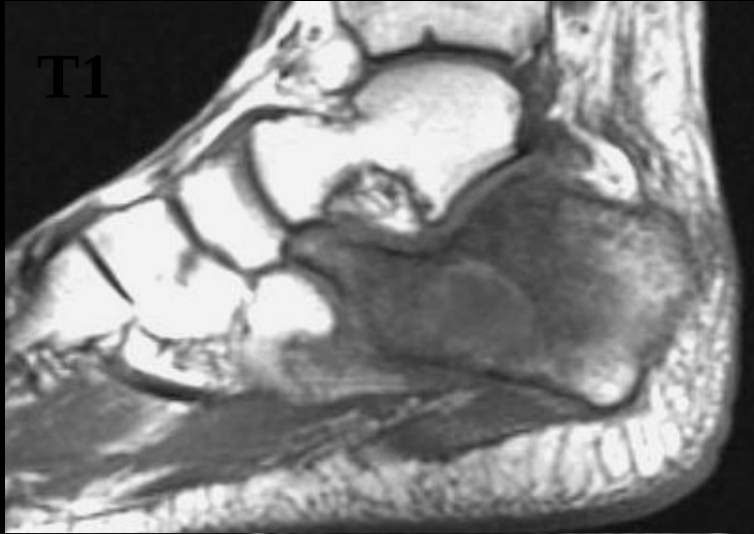
Table 2 (continued)

Current term	Definition	Controversy and rationale	Recommendations
Necrotizing fasciitis	An aggressive bacterial infection involving subcutaneous fat and deep fascial compartments	Clinical and imaging findings overlap with non-necrotizing fasciitis, pyomyositis, cellulitis with vascular thrombosis, prior radiation treatment	- CT should be recommended as the initial imaging study. The presence of gas bubbles is diagnostic, while their absence does not exclude this diagnosis Recommended term: necrotizing deep soft tissue infection
Joints/tendon sheaths			
Septic arthritis	Intra-articular infection	Imaging appearance similar to inflammatory or crystal arthropathies	- Any monoarticular destructive arthropathy should be regarded as septic arthritis until excluded - The term infectious or inflammatory arthritis may be used if the diagnosis is uncertain - Specific terms for type of infection of specific joint should be avoided - Acceptable to use term septic sacroiliitis Recommended terms: septic arthritis, septic sacroiliitis, or infectious or inflammatory arthritis when the diagnosis is uncertain
Synovitis	Inflammation of the synovial-lined spaces of joints, bursae, or tendon sheaths	Nonspecific term applying to infectious and non-infectious conditions	- When reported, recommend including a differential diagnosis including an estimation of risk Recommended term: synovitis
Septic or infectious tenosynovitis	Infection of tendon sheath	Imaging overlap with tenosynovitis due to inflammatory or crystal arthropathies	- Septic or infectious tenosynovitis may be used when imaging findings match clinical picture - Term should be avoided in tendons without sheath (i.e., Achilles). Instead, infectious paratenonitis or infection of a specific tendon (i.e., infection of the Achilles tendon) recommended Recommended terms: Septic or infectious tenosynovitis, infectious paratenonitis, or infection of tendon (in tendons without a sheath)
Erosion	Loss of subchondral bone plate integrity	- May represent early stage of medullary involvement and osteomyelitis in the context of septic arthritis - Also seen in inflammatory or crystal arthropathies	- May be used in the context of septic arthritis, with caveat of possible early osteomyelitis, particularly with extension beyond the immediate subchondral bone Recommended term: erosion
Bone surface			
Periosteal reaction, periostitis, periosteal new bone formation	The reaction of periosteum to abnormal stimulants by forming new bone in distinctive patterns	Paucity of MRI literature on term due to lower MR spatial resolution, marrow signal changes specific for osteomyelitis	Recommended term: periosteal reaction
Subperiosteal abscess	Encapsulated fluid collection confined to the subperiosteal space	May be difficult to differentiate subperiosteal abscess from phlegmon	Recommended term: subperiosteal spread of infection

Table 2 Summary of terms, controversy, and recommendations for musculoskeletal infection on MRI

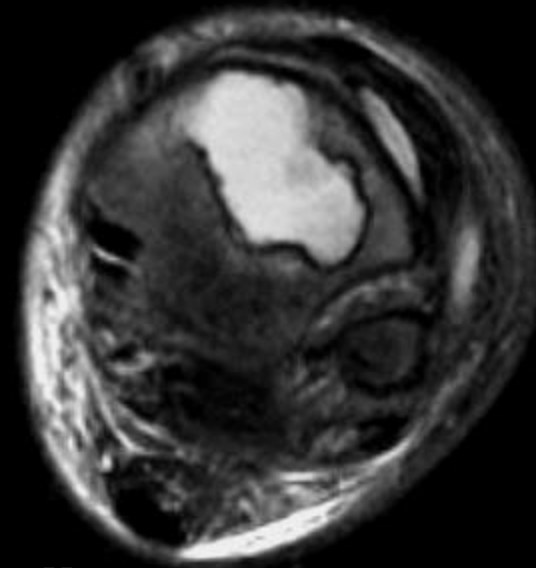
Current term	Definition	Controversy and rationale	Recommendations
Soft tissue			
Edema	A local or generalized condition in which body tissues contain an excessive amount of fluid in the interstitial spaces Bland edema: non-inflammatory edema	Differentiation of bland edema from cellulitis	- Without intravenous contrast, confluent subcutaneous edema can be reported as high or low likelihood of cellulitis based on the presence or absence of secondary imaging features (i.e., ulcer, sinus tract, demarcated fluid collection) Recommended term: edema
Cellulitis	Non-necrotizing superficial bacterial infection	Differentiation of bland edema from cellulitis	- Cellulitis should be used for enhancing superficial soft tissues Recommended term: cellulitis
Ulcer	Breach in the continuity of skin, epithelium, or mucous membrane	Granulated ulcers may not have an identifiable skin breach but carry a similar risk of deep infection	- Accurately describe any associated soft tissue and/or osseous infection whenever an ulcer is visible on imaging or identified clinically - Tailor field of view to region of concern and place markers adjacent to shallow ulcers Recommended term: ulcer
Sinus tract	An abnormal channel that originates from the skin or a mucous surface to a deep-seated focus of suppuration	Squamous cell carcinoma is an uncommon complication that may develop in the sinus tract patient with longstanding osteomyelitis	- Should be evaluated in all imaging planes - While sinus tract is not specific to infection, it is an appropriate term for processes isolated to the soft tissues Recommended term: sinus tract
Soft tissue abscess	Localized collection of pus in any body part resulting from invasion of a pyogenic bacterium or other pathogen, with a peripheral capsule created by macrophages, fibrin, and granulation tissue	Difficult to discern without intravenous contrast or diffusion-weighted imaging (DWI)	- Soft tissue abscess should be used for demarcated fluid collections with peripheral enhancement or with restricted diffusion or presence of penumbra sign if contrast is not administered - Intramuscular abscess is preferred term if there is a defined walled-off intramuscular fluid collection - Avoid classifying an abscess as drainable based on imaging features - Histopathology terms, such as tissue necrosis, liquefied necrosis or tissue infarction are discouraged Recommended terms: soft tissue abscess, intramuscular abscess
Phlegmon	Acute or infiltrative phase ill-defined inflammatory mass-like lesion, prior to liquefaction and pseudocapsule formation (pre-abscess)	- Does not specify the presence of infection - DWI may show abscess in a region of phlegmonous change	- The term phlegmon is discouraged as it would not lead to meaningful clinical action or impact Recommended terms: rather than phlegmon, use accepted terms such as cellulitis, myositis, or fasciitis, without soft tissue abscess
Devitalized tissue	Necrotic or ischemic soft tissue	- Only visible after contrast administration - Unclear whether tissue is truly necrotic or ischemic	- Recommend contrast administration to reveal devitalized tissue and optimize resection - Carefully scrutinize the soft tissues underneath or beyond ulcer margin for devitalized tissue Recommended term: devitalized tissue

Iatrogenic Osteomyelitis

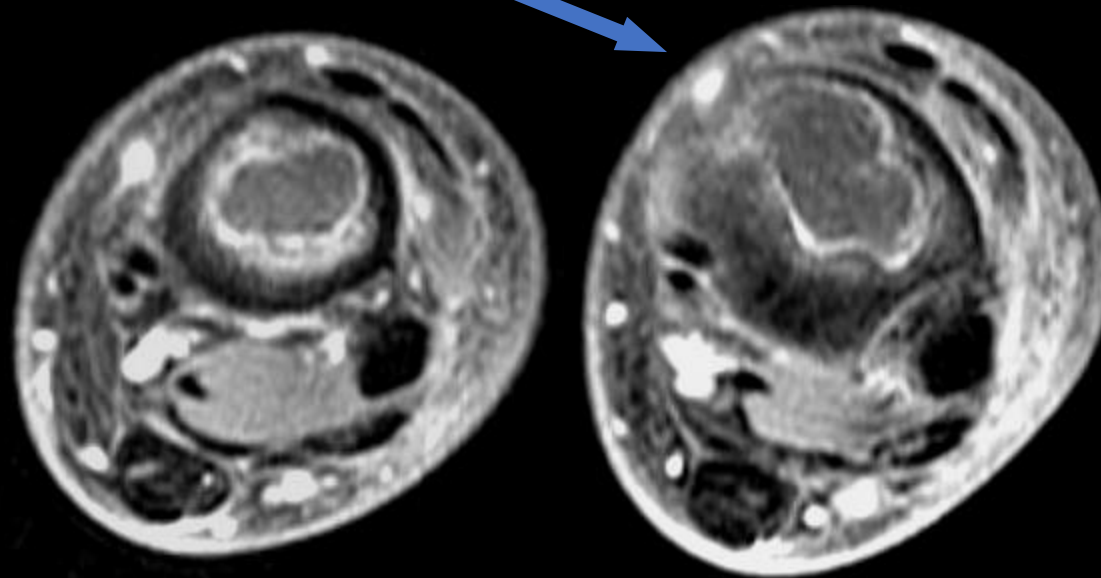


Intra-osseous abscess (Brodie's)

Focal fluid signal in marrow with
surrounding rim enhancement
with or without cloaca



Surgically proven

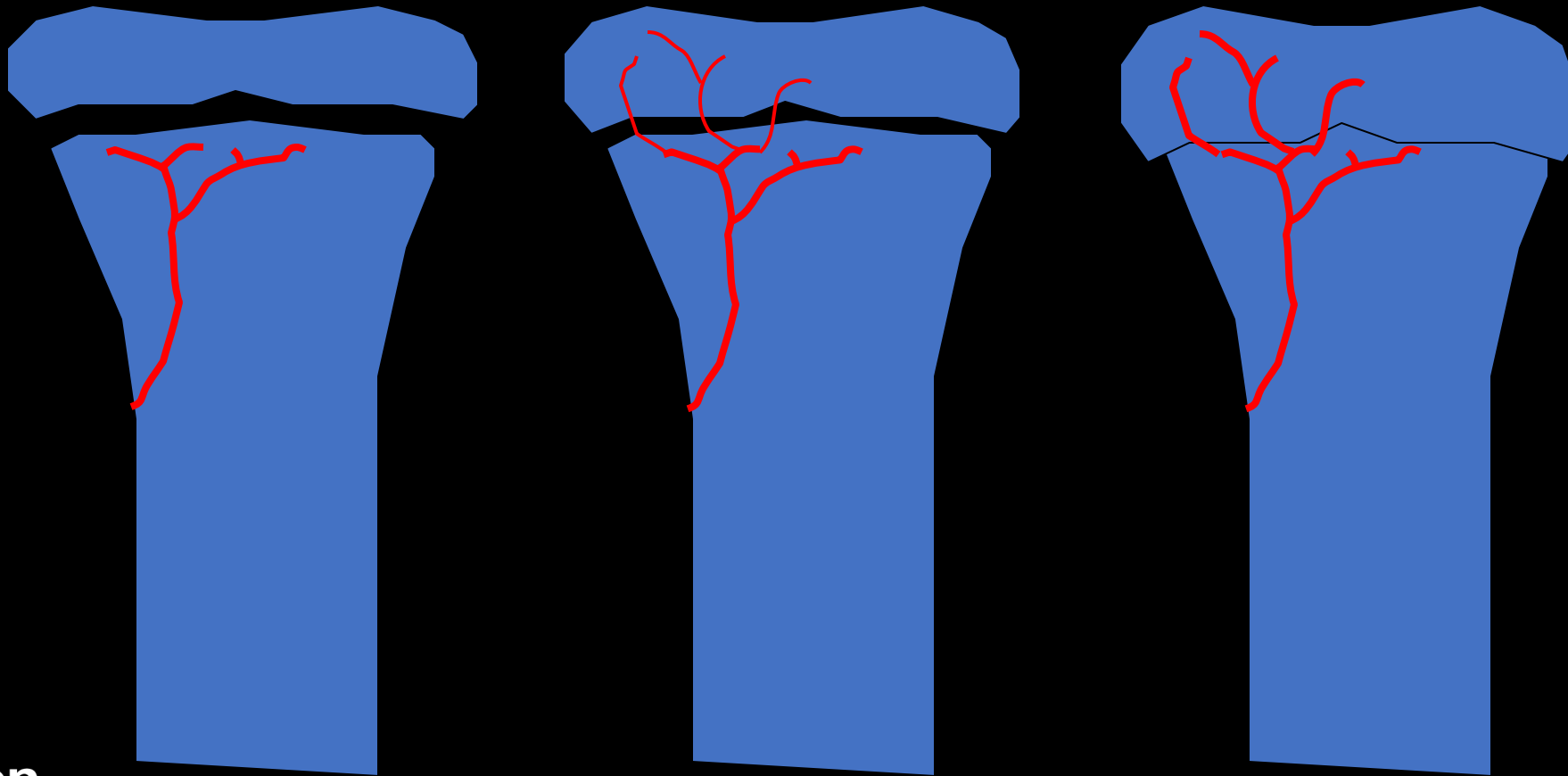


Pediatric Osteomyelitis

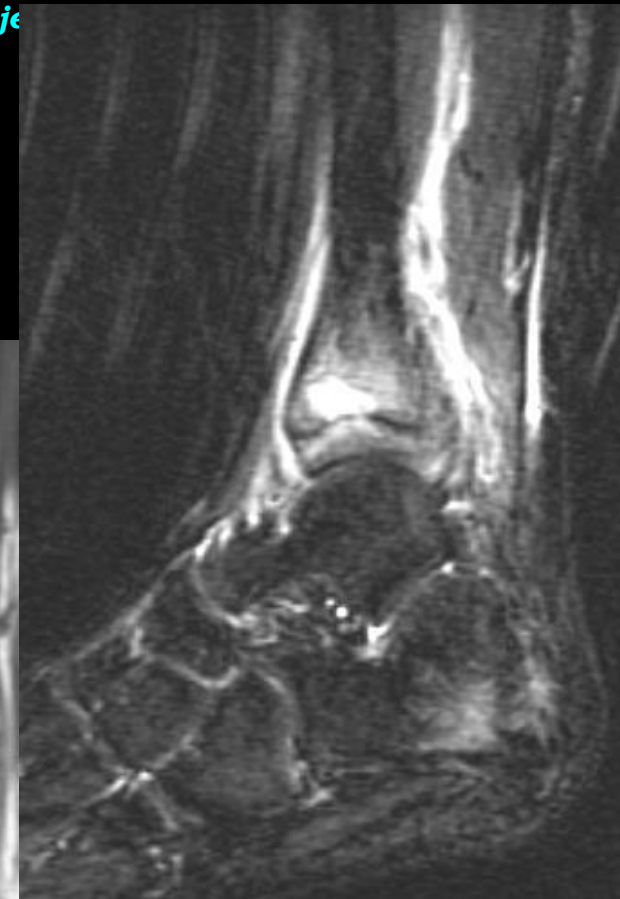
- Incidence: 5/10,000
- 1% of pediatric hospital admissions
- Hematogenous most common
 - Septic arthritis
 - Hip common: bacterial vs. 'reactive synovitis'
 - Look for any asymmetry at medial joint
 - US can be equivocal
 - Aspirate
 - Osteomyelitis
 - Relation to trauma increases with age



Pediatric Osteomyelitis

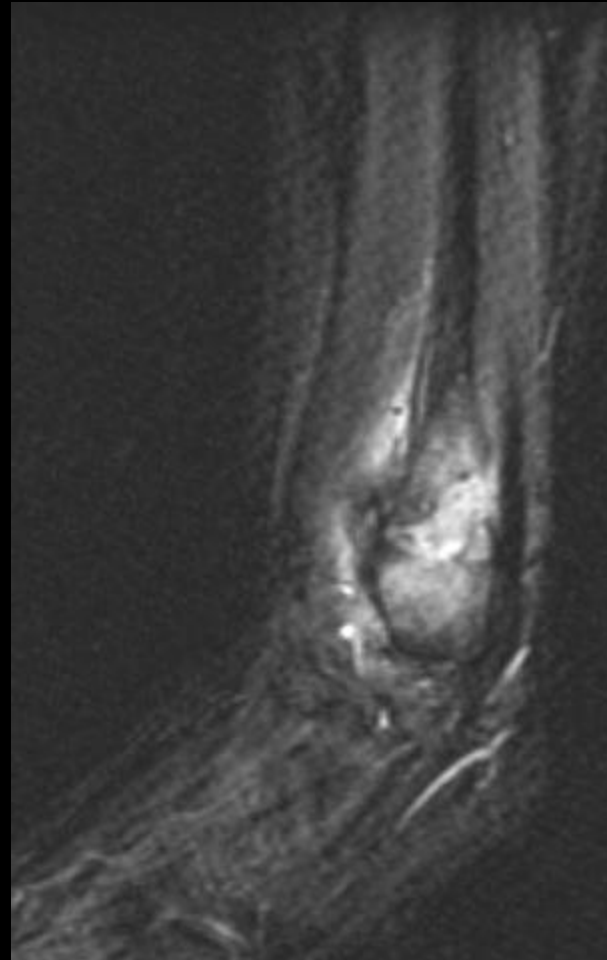


Brodie's Abscess

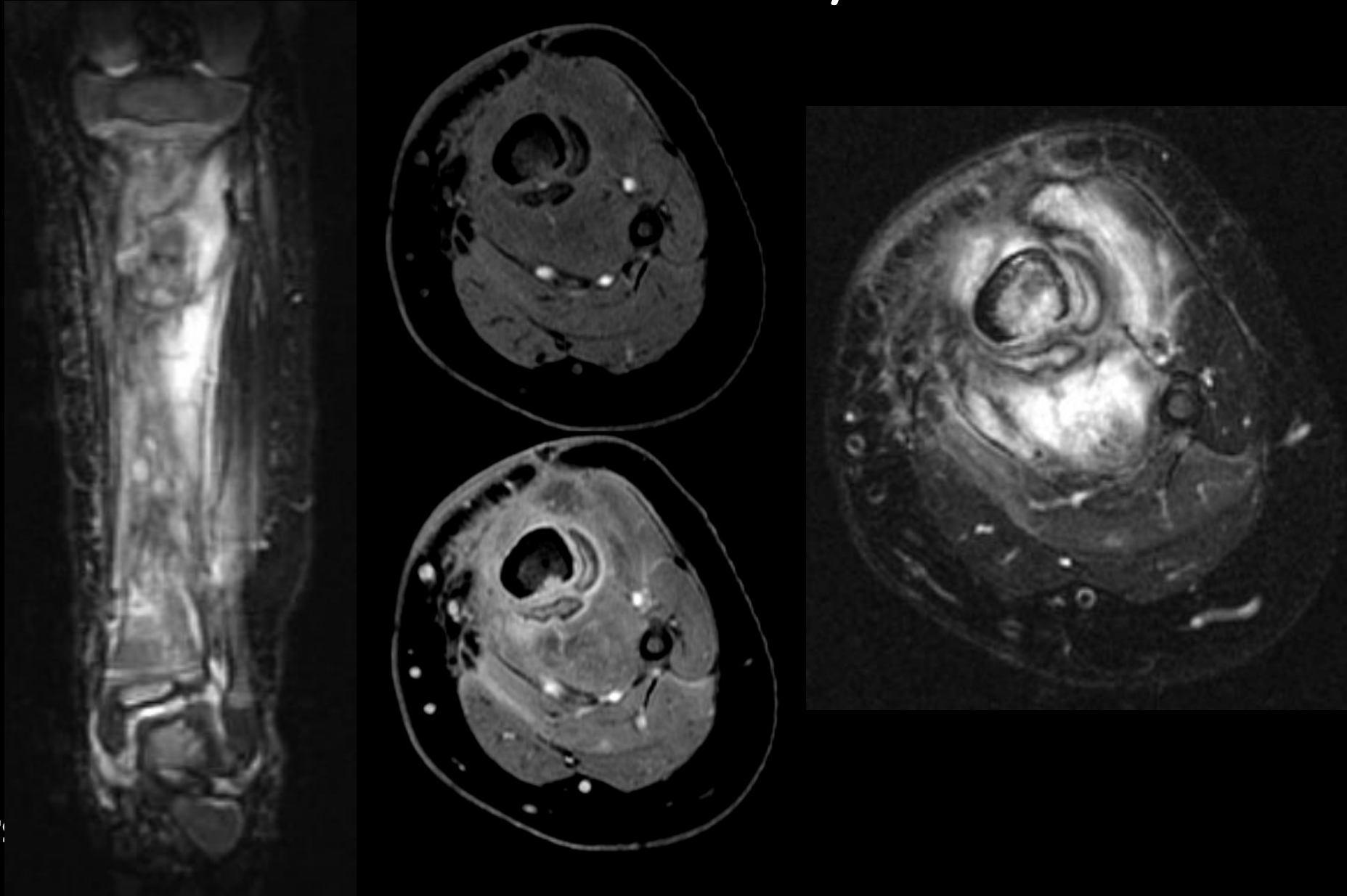


- Metaphyseal
- Distal tibia most common
- 'Drips' to physis

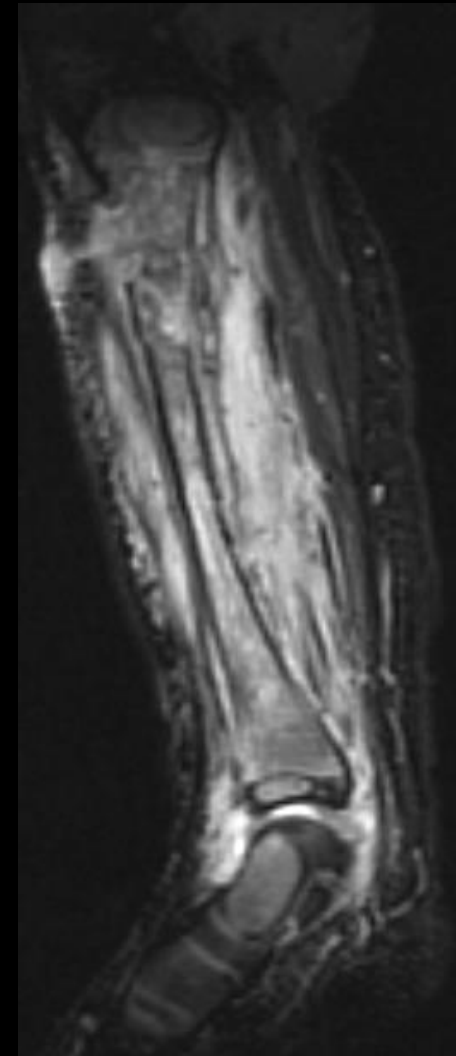
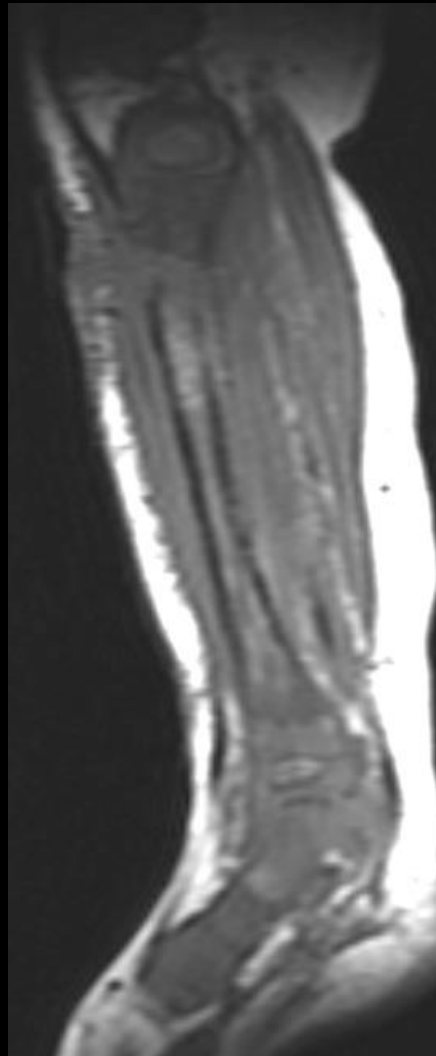
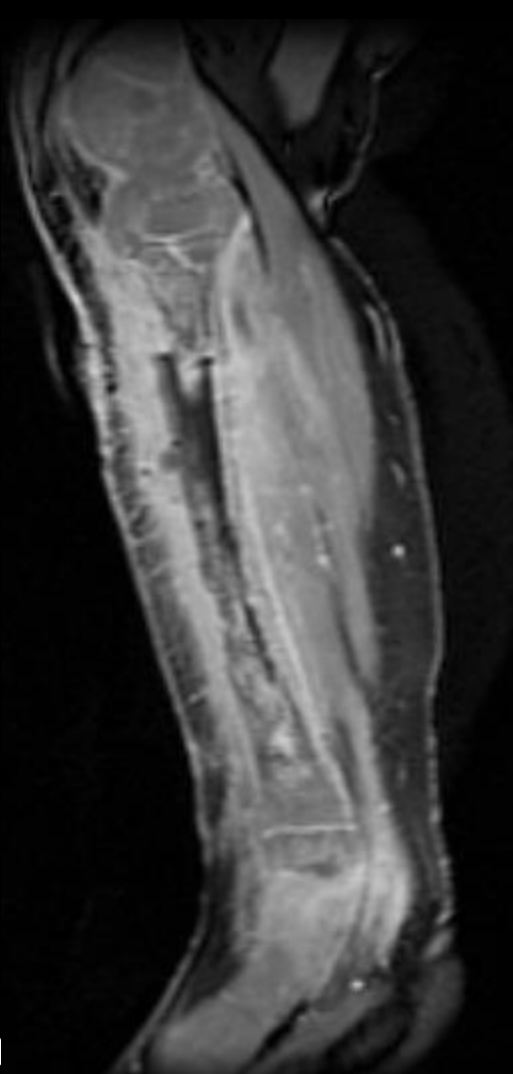
Brodie's with cloaca



Acute on Chronic Osteomyelitis



Extensive Osteomyelitis in 4 year old

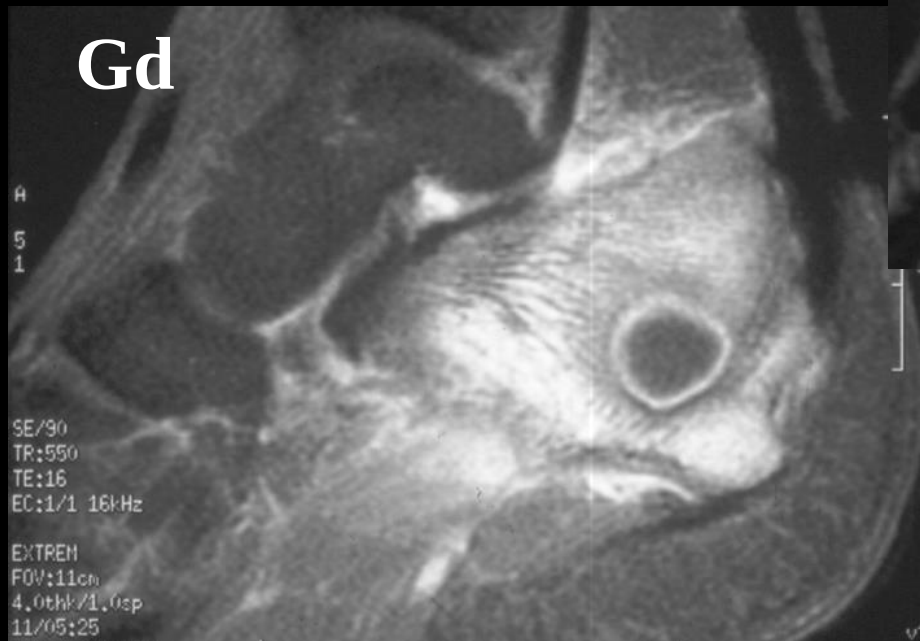
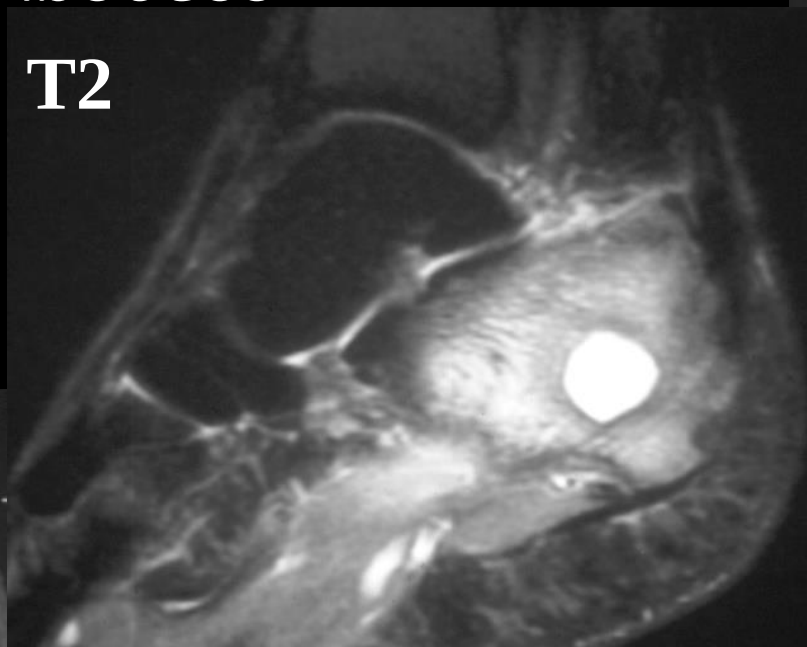
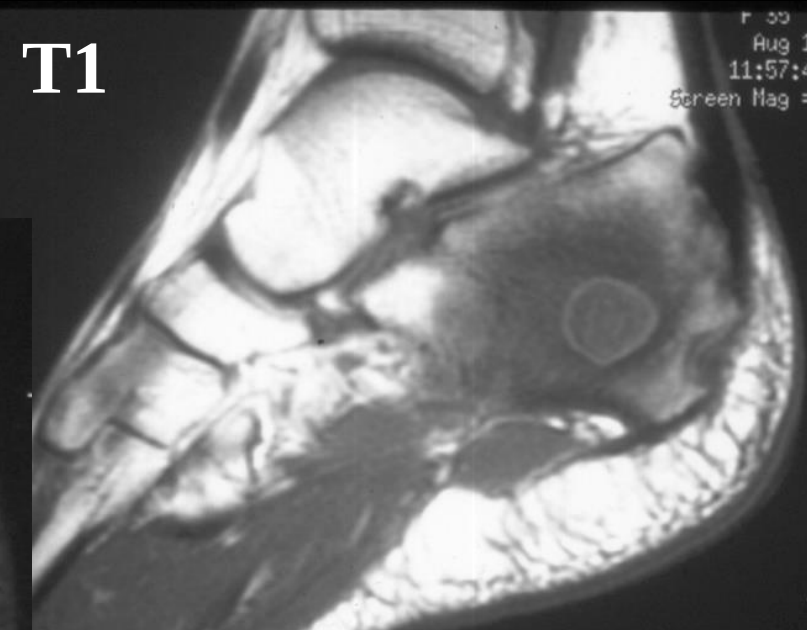


Direct Inoculation with sinus tract



Direct Inoculation

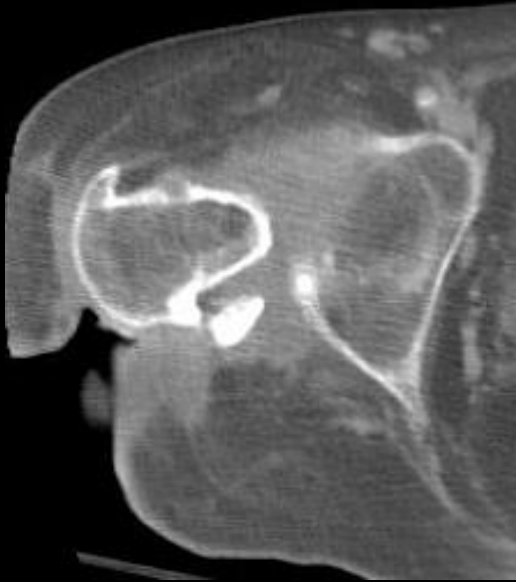
Chronic Intraosseous Abscess



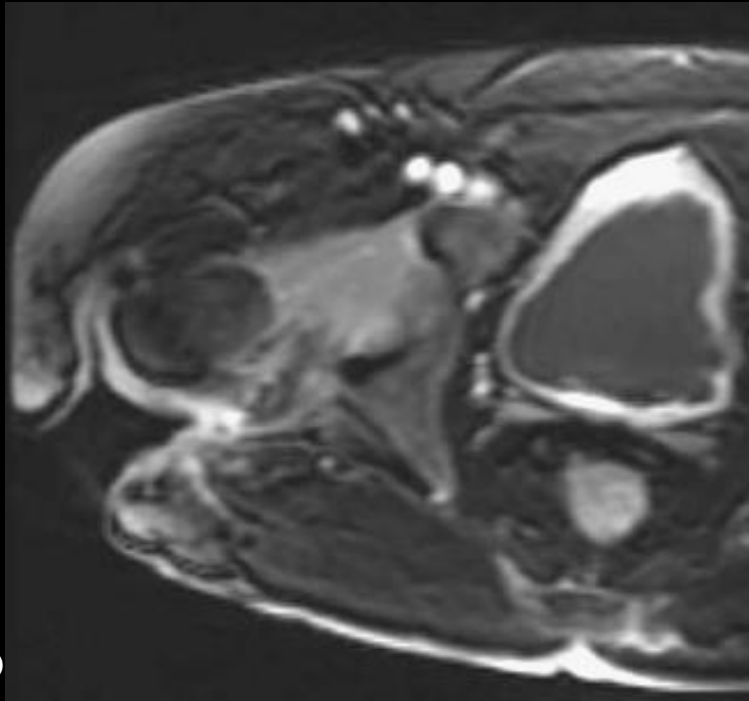
The Paralyzed Patient

- Decubitus ulcers
- Chronic osteomyelitis
- Heterotopic bone formation



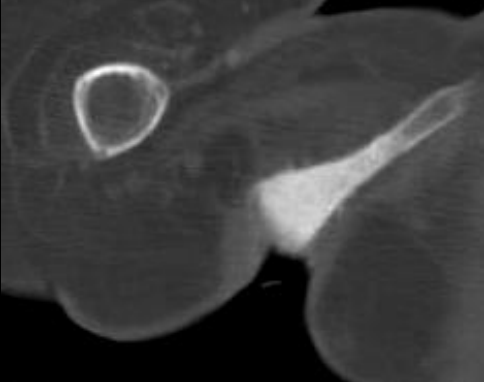


Decubitus ulcers: ischium or greater trochanter

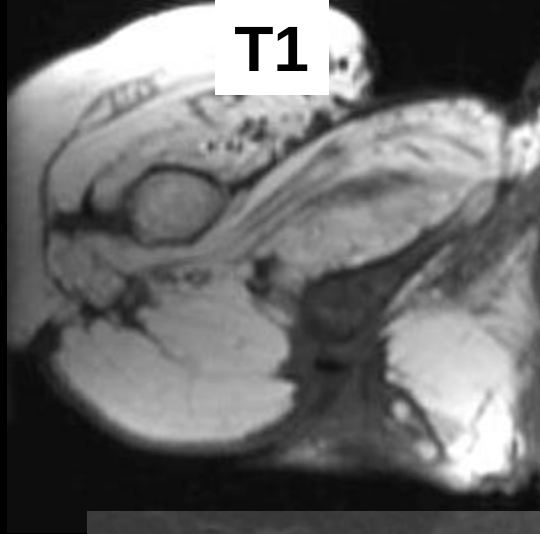


Often generates an eschar like barrier to frank osteomyelitis

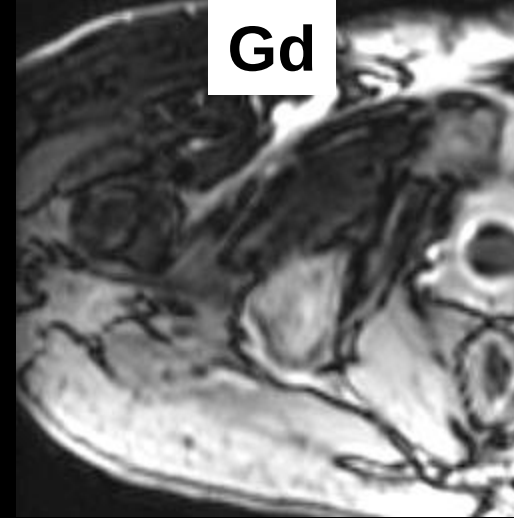
CT



T1

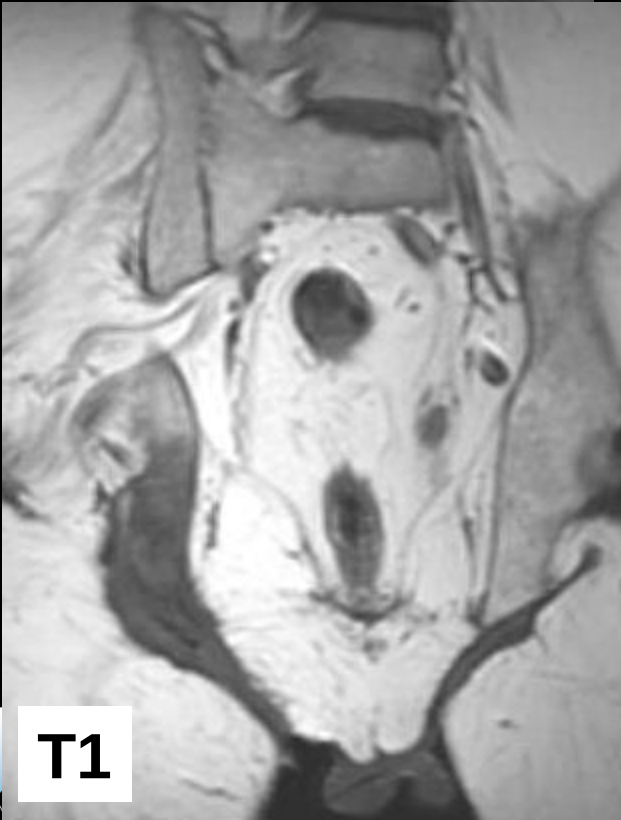


Gd

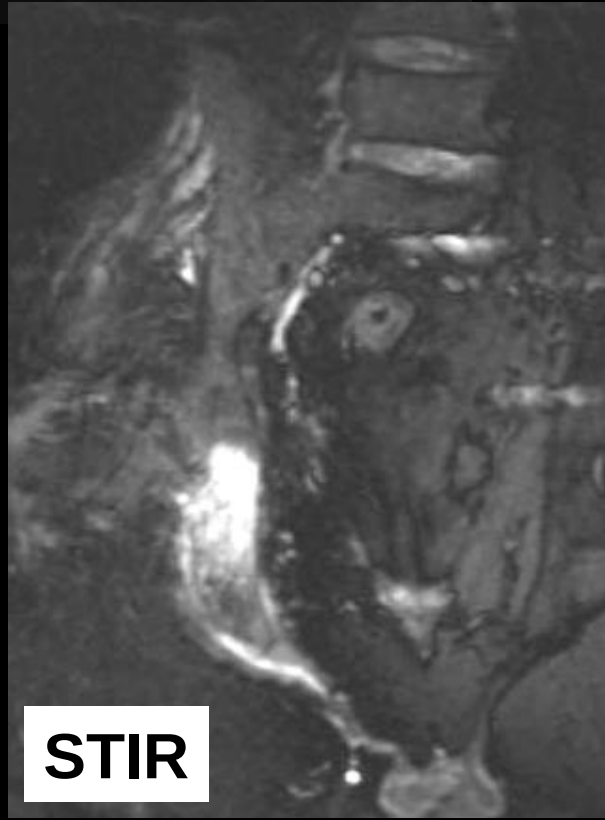


Chronic
Osteomyelitis with sinus
tract from decubitus ulcer

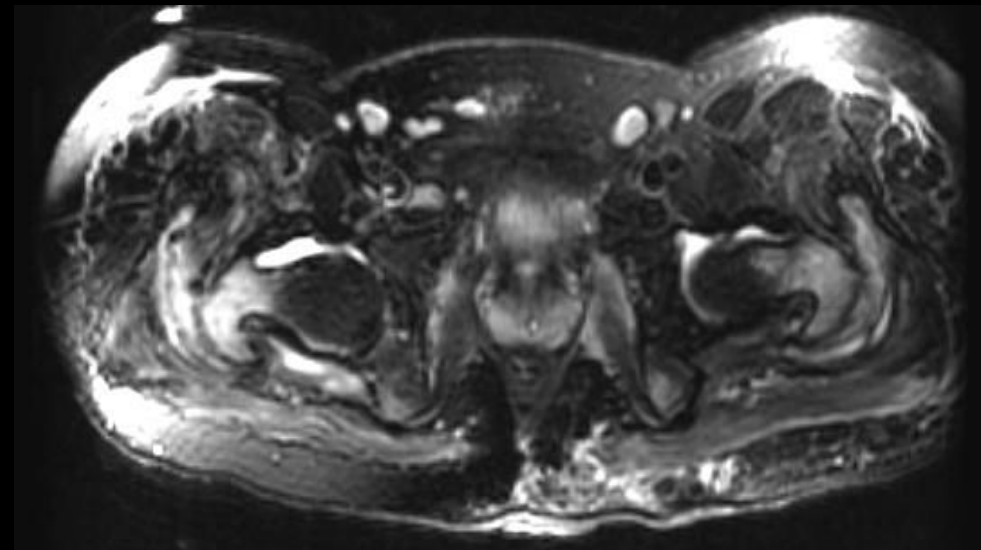
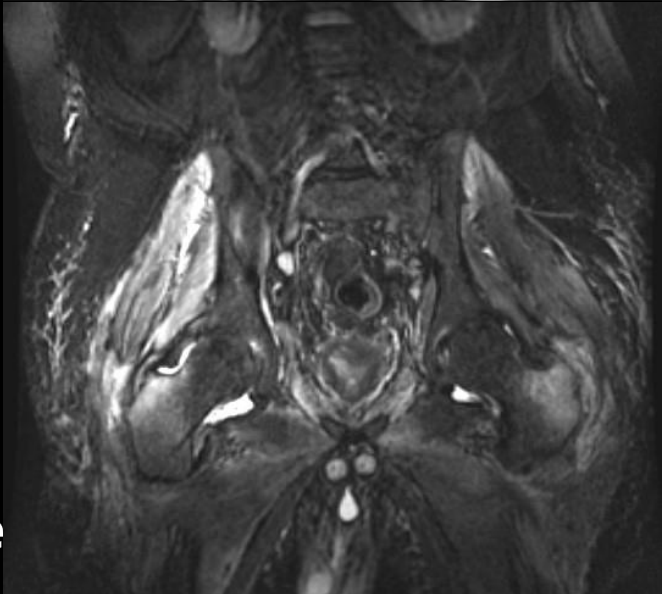
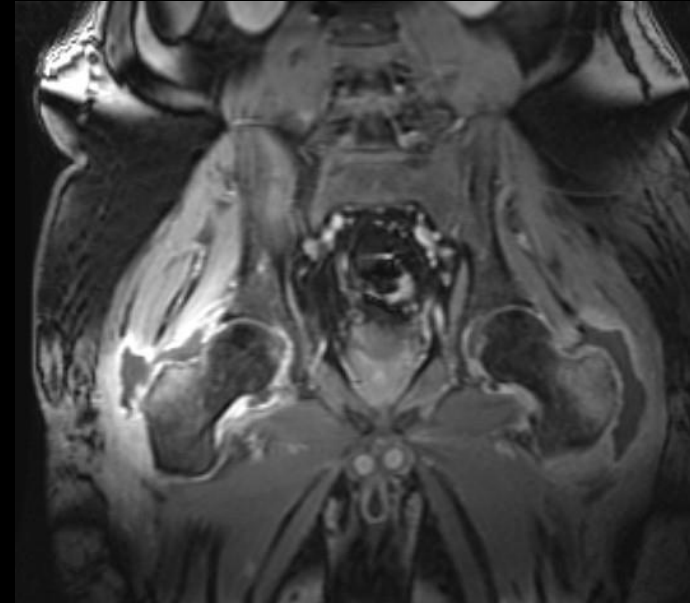
T1



STIR

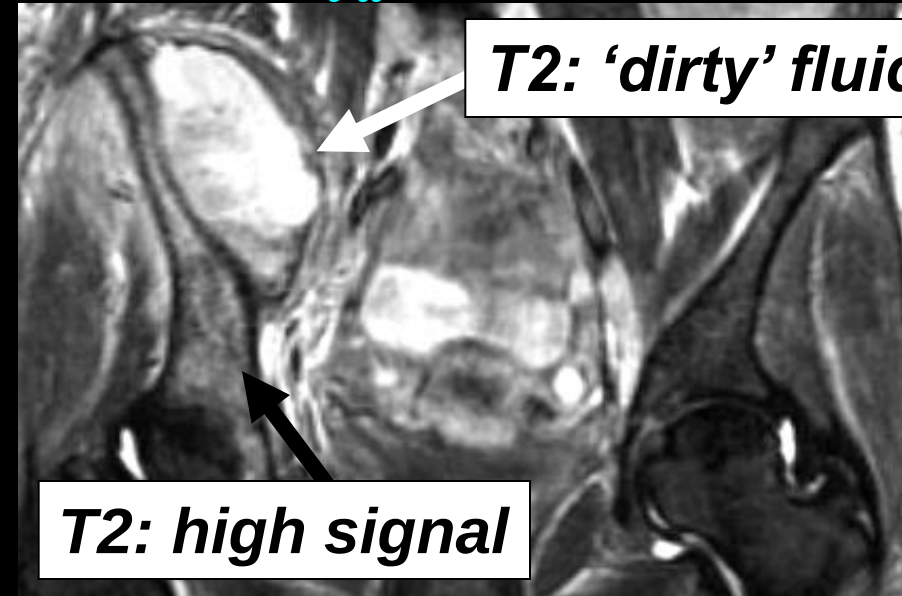


Septic Greater Trochanteric Bursitis





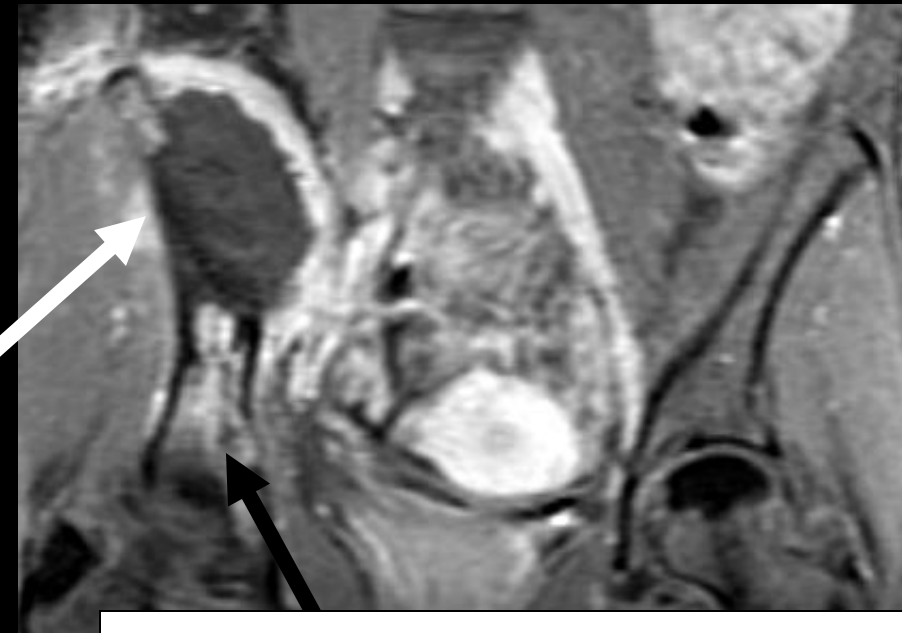
T1: low signal



T2: 'dirty' fluid

T2: high signal

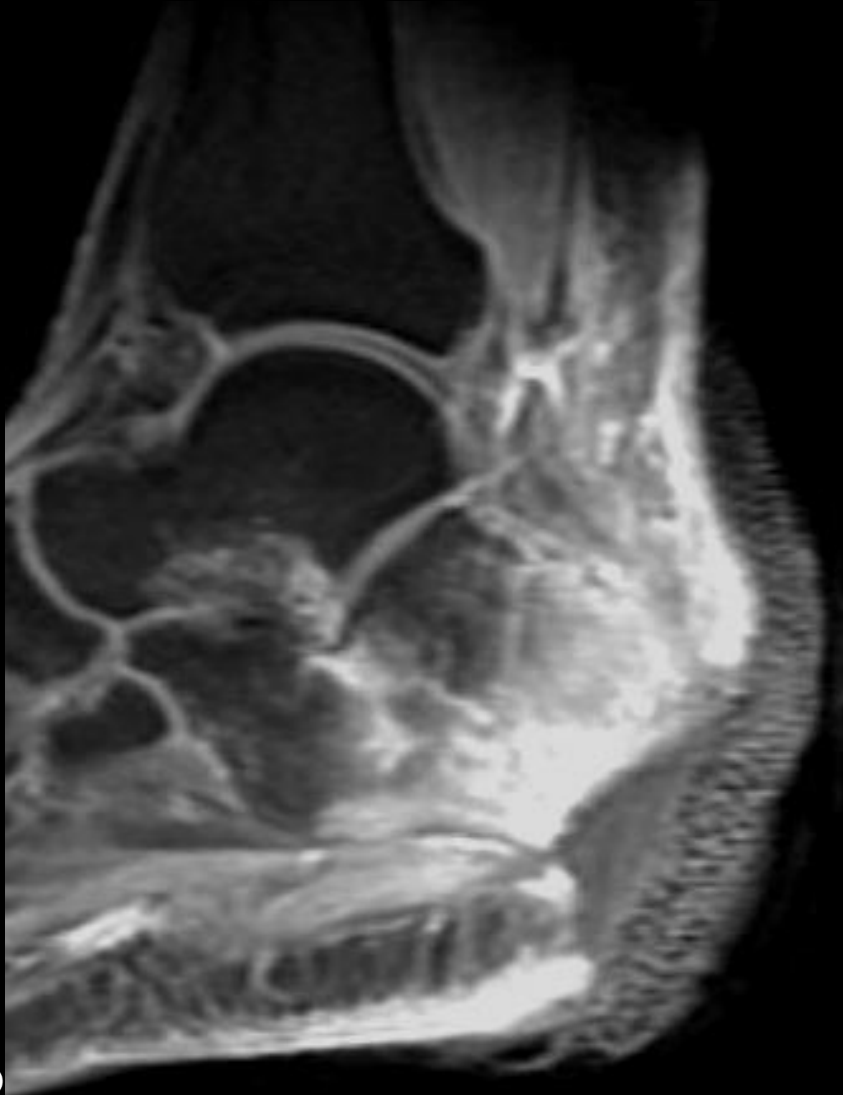
Osteomyelitis



Gd: thick rim enhancement

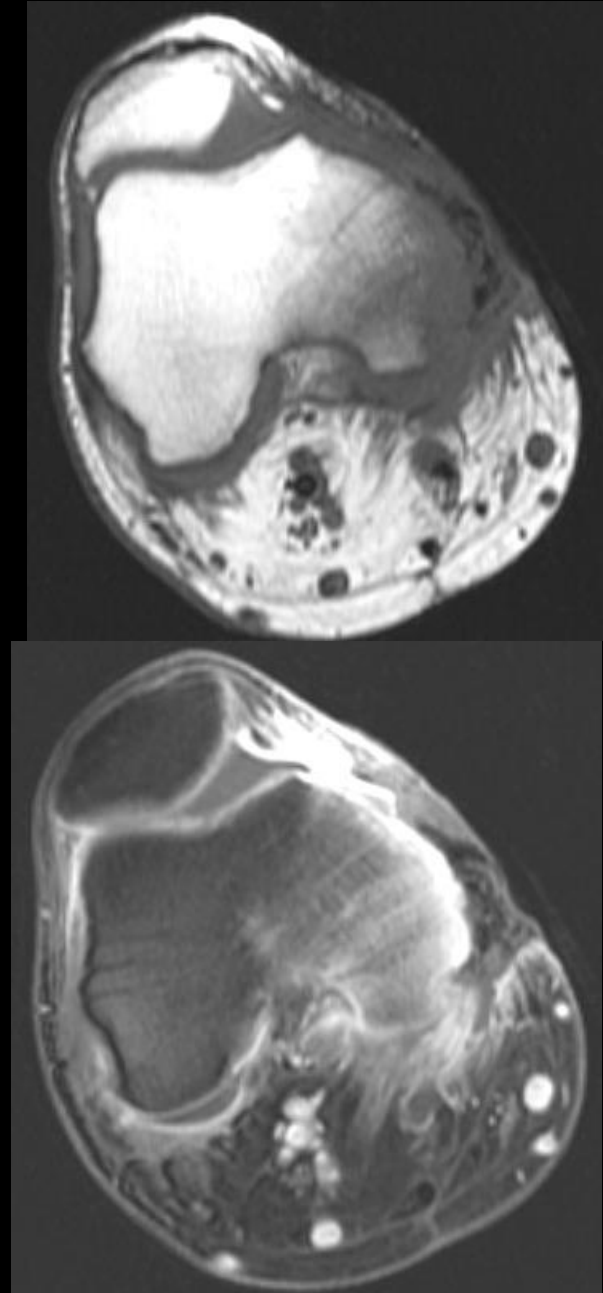
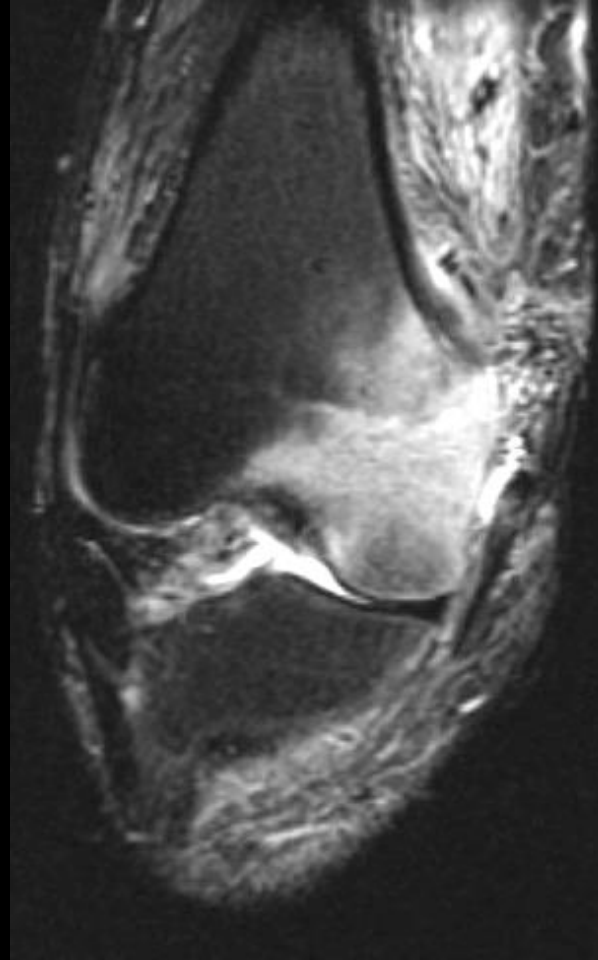
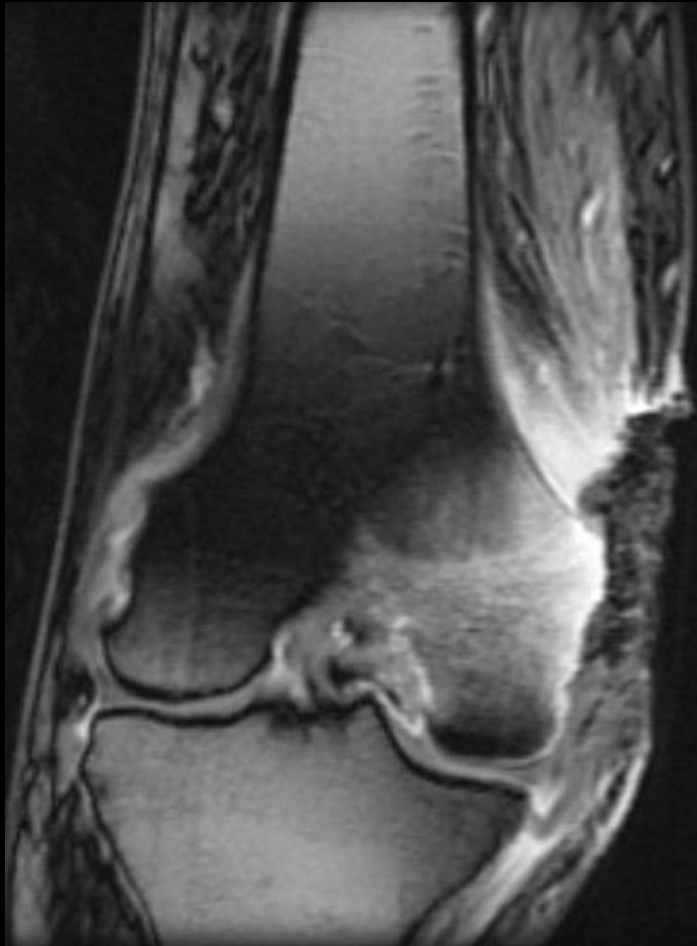
Gd: marrow enhancement

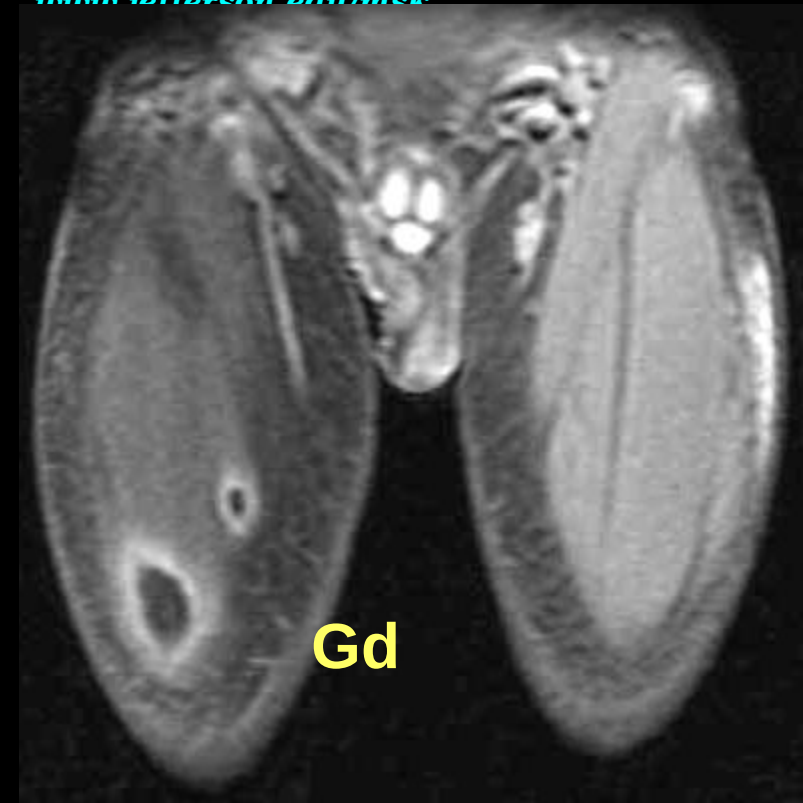
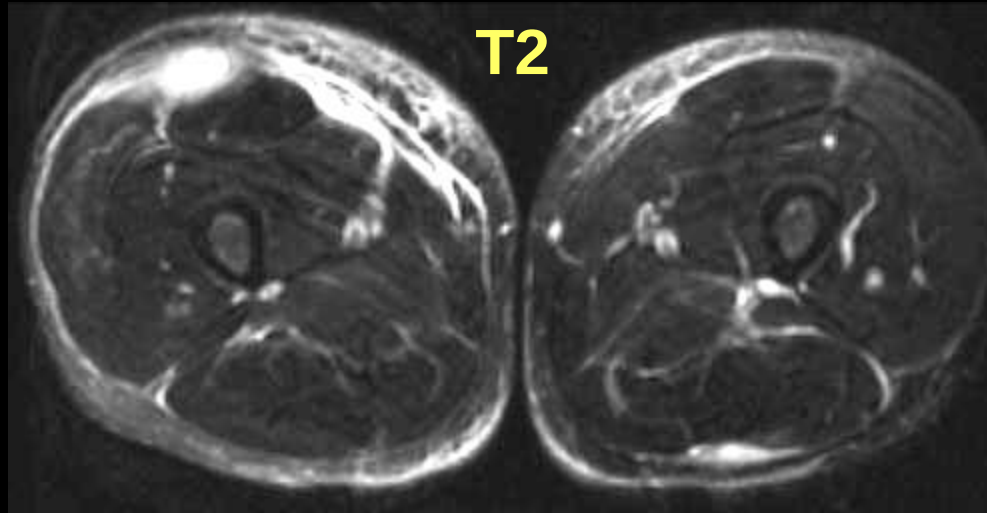
Calcaneal Ulceration



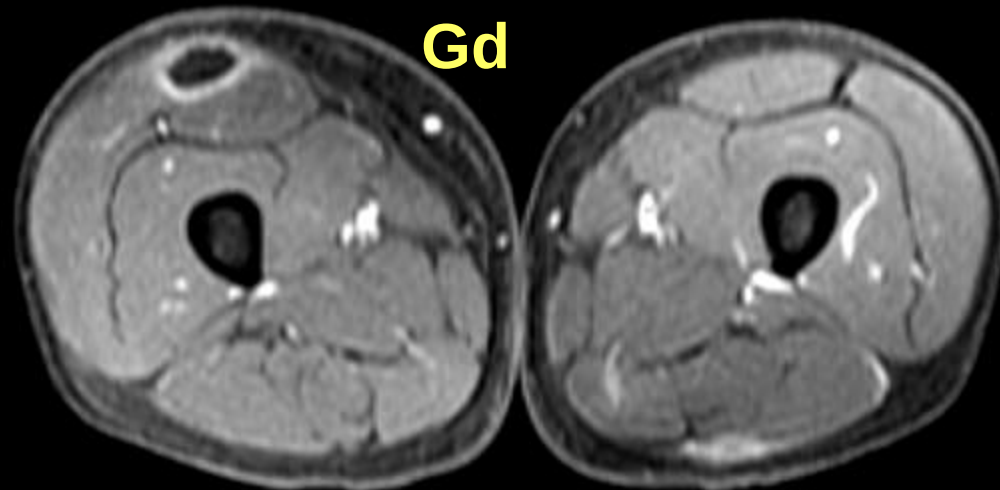
Osteomyelitis direct extension

Osteomyelitis from injection





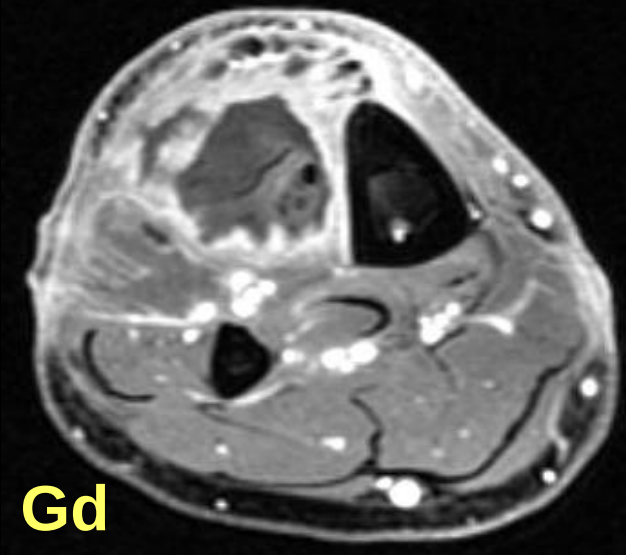
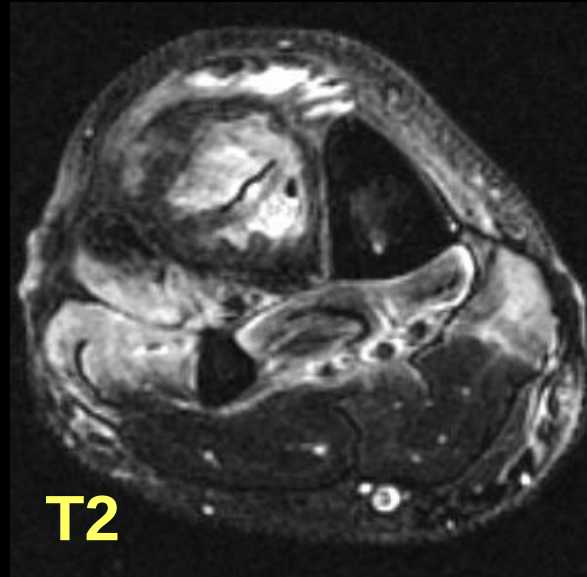
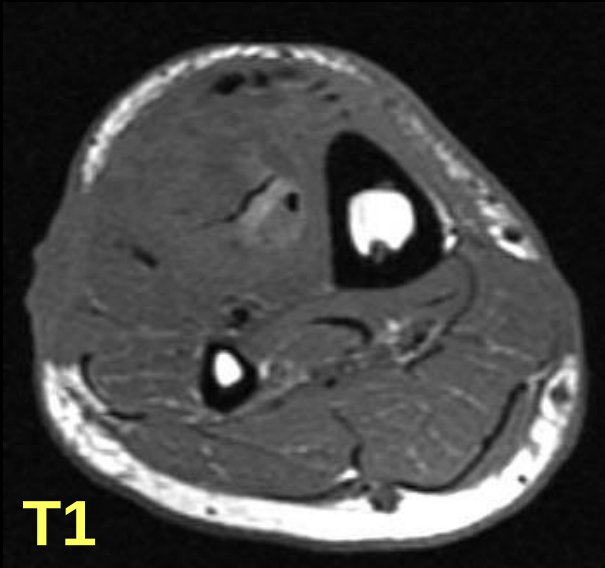
Pyomyositis
Hematogenous spread
(intramuscular abscess)



Pyomyositis

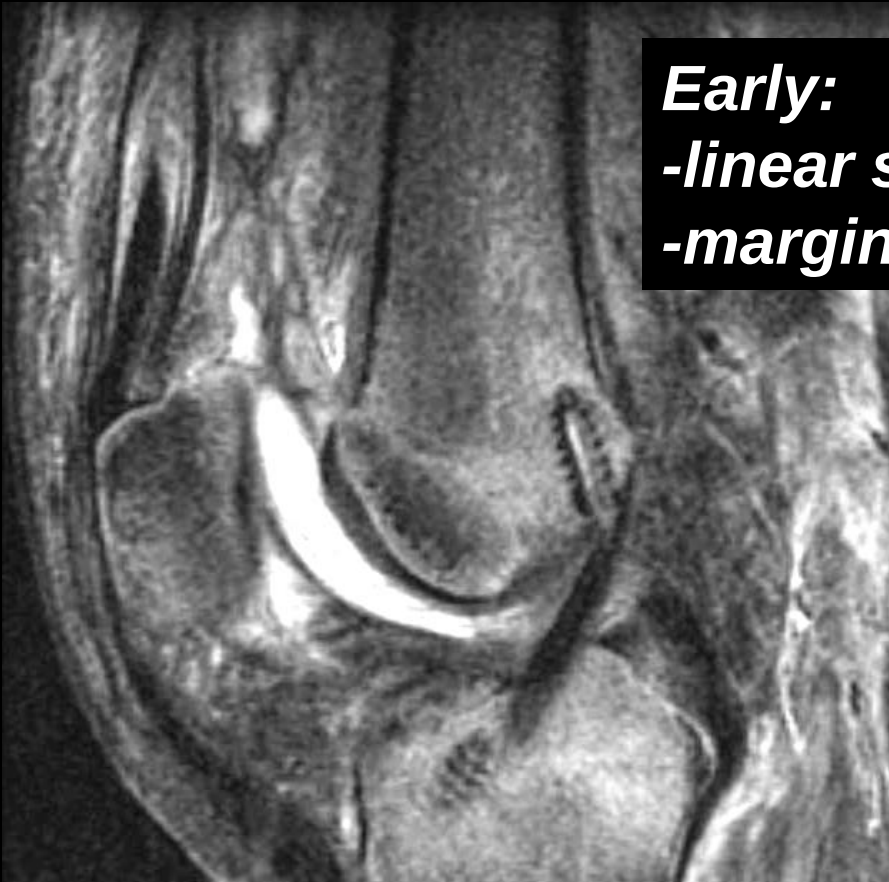
- Hematogenous spread vs. direct implantation
- Various organisms
- Systemic sx of infection
- Cellulitis
- Muscle enlargement
- Focal fluid signal in muscle
- Areas of rim-enhancement with Gd

Pyomyositis with Secondary Compartment Syndrome



Post-operative Infection

Post op ACL Reconstruction *Septic Arthritis / Osteomyelitis*

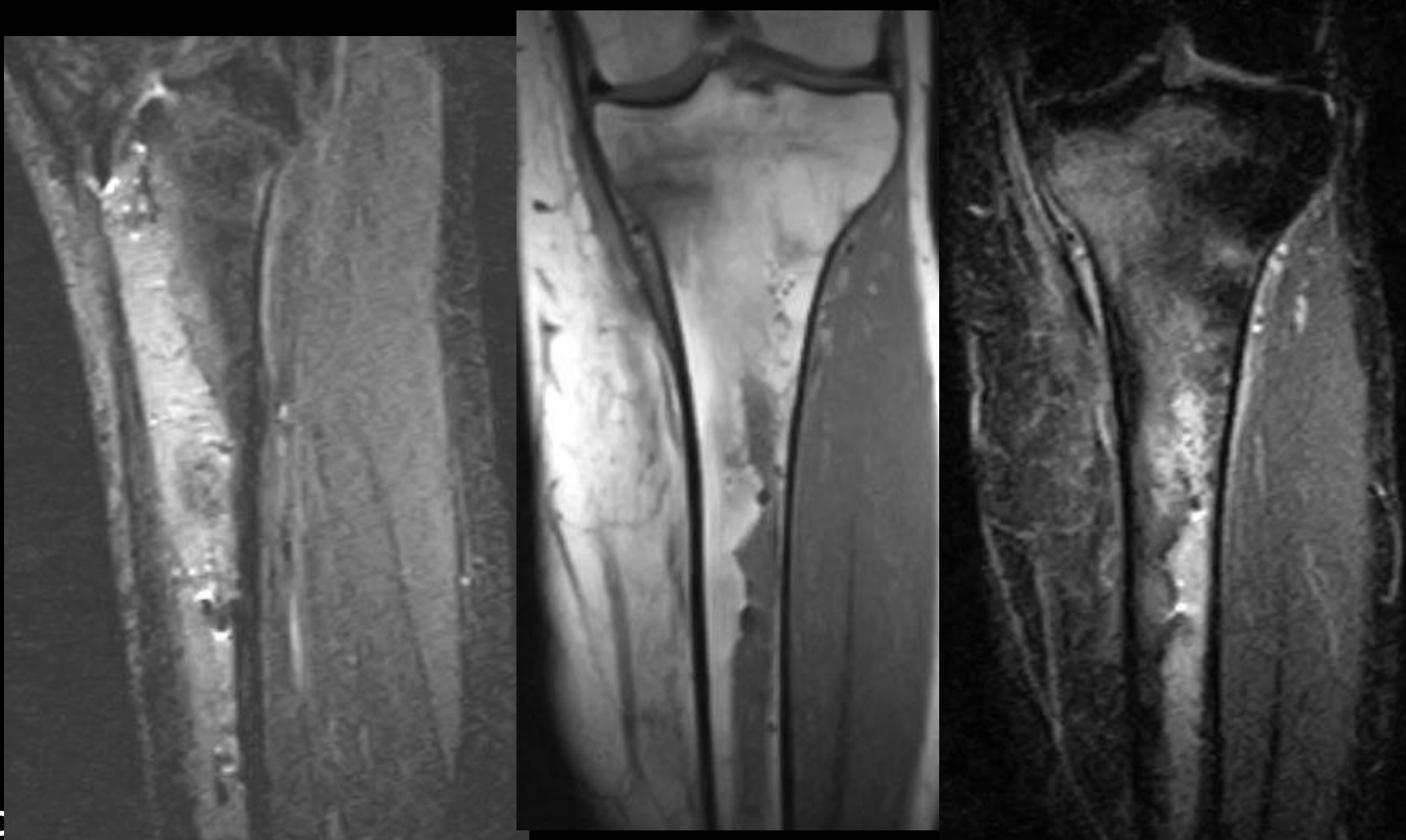


Early:
-linear subchondral edema
-marginal destruction



Late:
Medullary osteomyelitis

Post Medullary Nail



Complications of Infection

- Chronic osteomyelitis
- Squamous cell CA

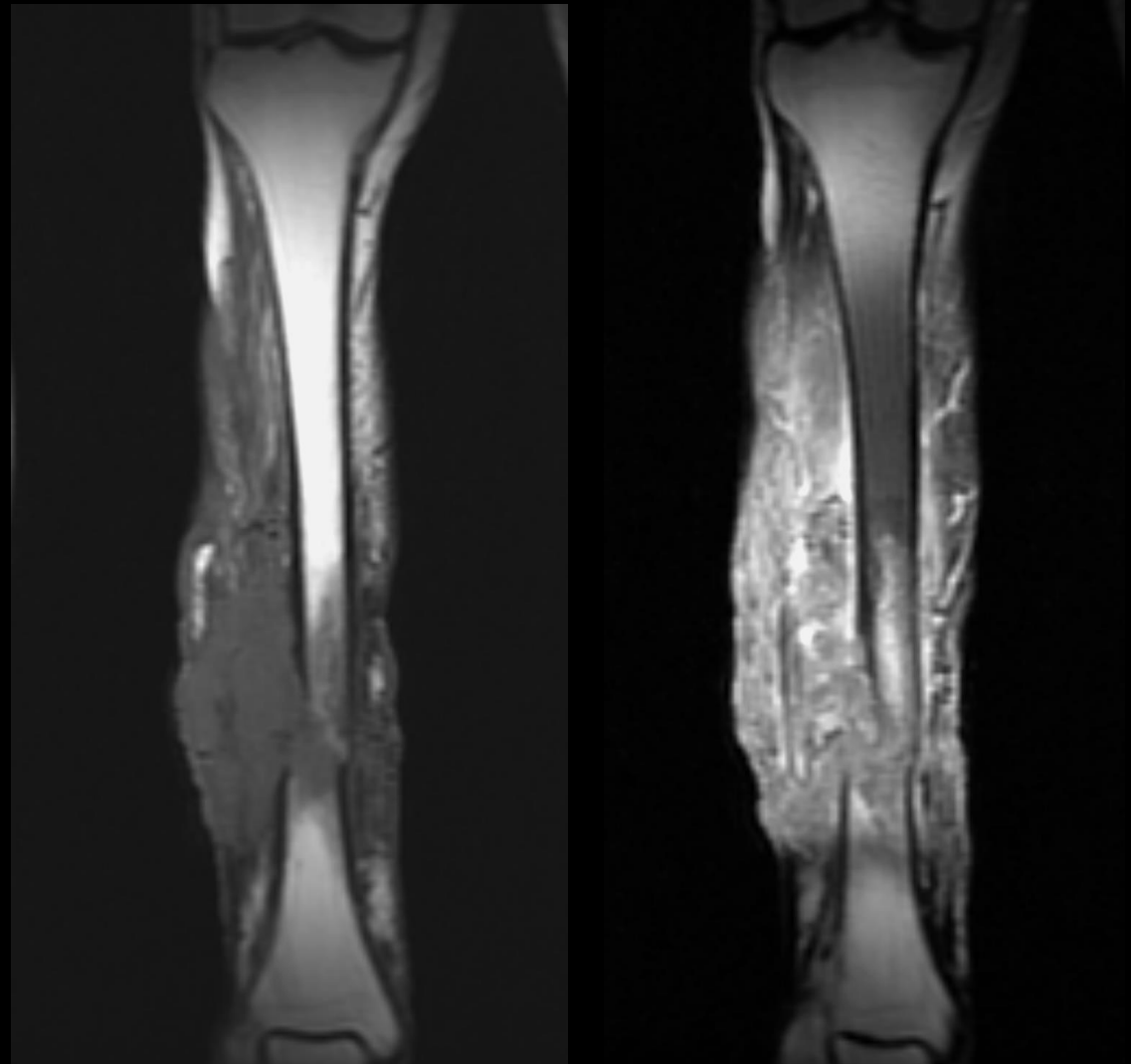
1. Altay M, Arikan M, Yildiz Y, Saglik Y. Squamous cell carcinoma arising in chronic osteomyelitis in foot and ankle. *Foot Ankle Int.* 2004 Nov;25(11):805-9. Review. PubMed PMID: 15574240.
2. Fitzgerald RH Jr, Brewer NS, Dahlin DC. Squamous-cell carcinoma complicating chronic osteomyelitis. *J Bone Joint Surg Am.* 1976 Dec;58(8):1146-8. PubMed PMID: 1002759.

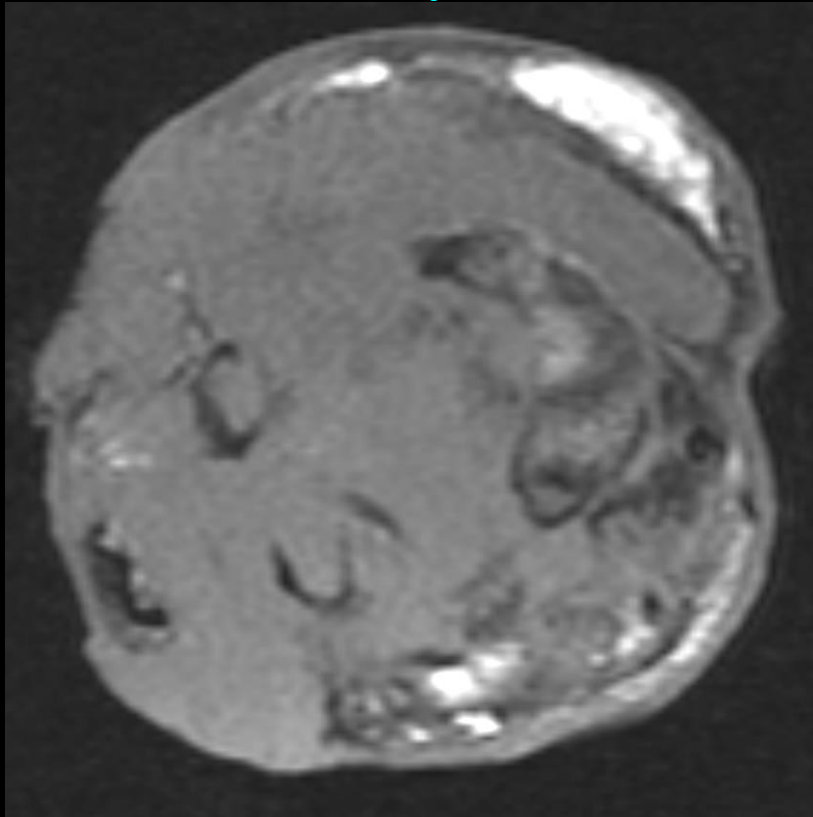




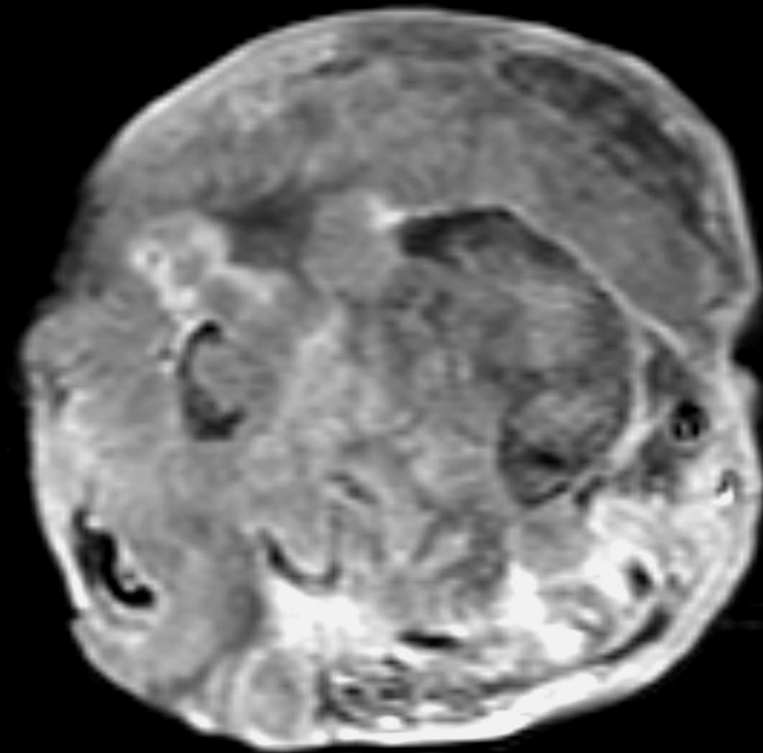
Post Osteo Squamous Cell Atypical MR Features

- Infected devitalized tissue
- Chronic osteomyelitis





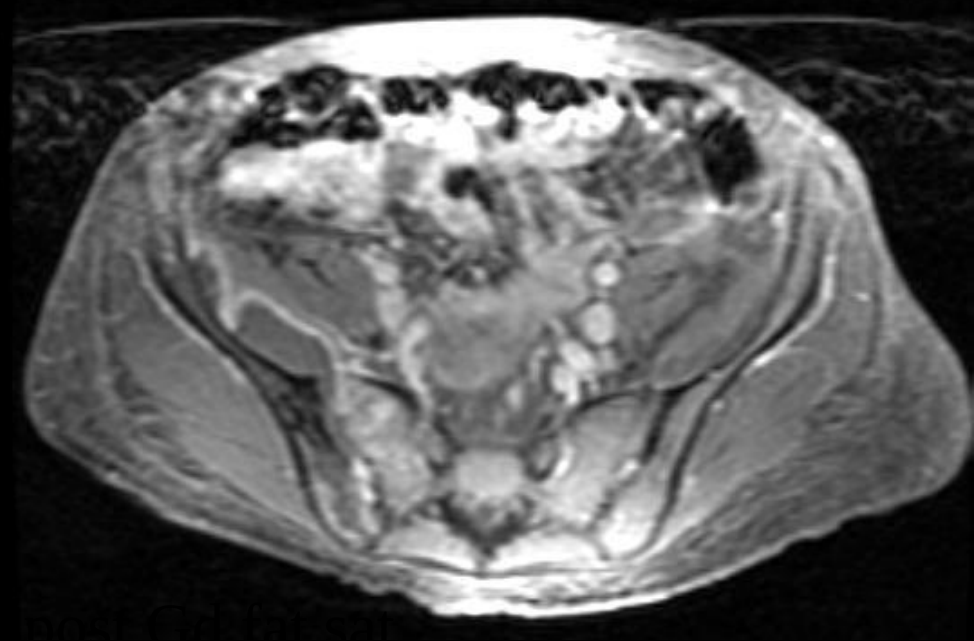
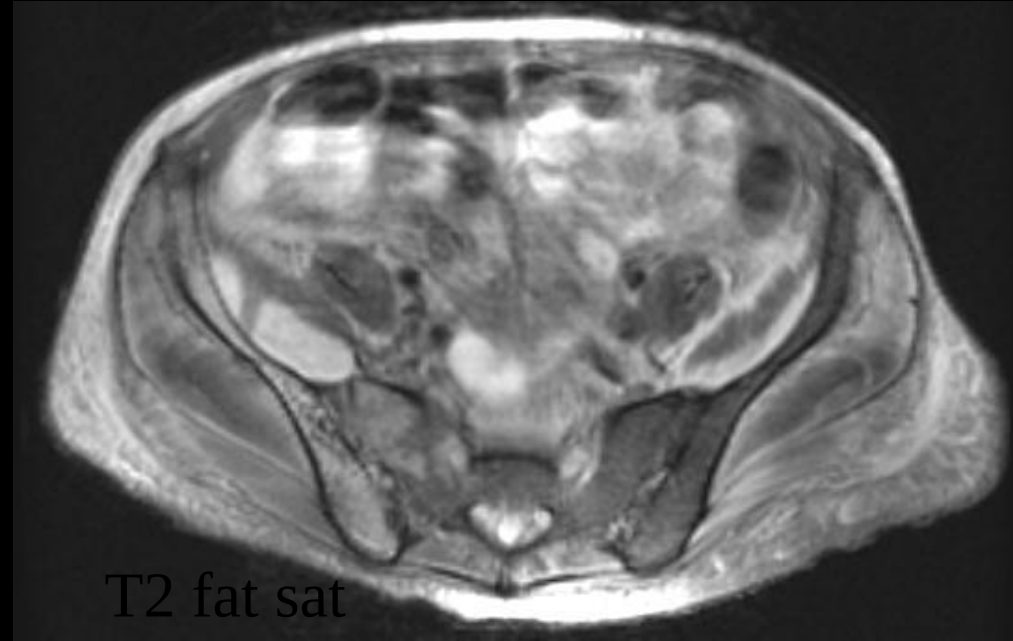
***Squamous cell CA
Arising from chronic sinus tract***



Necrotic tissue

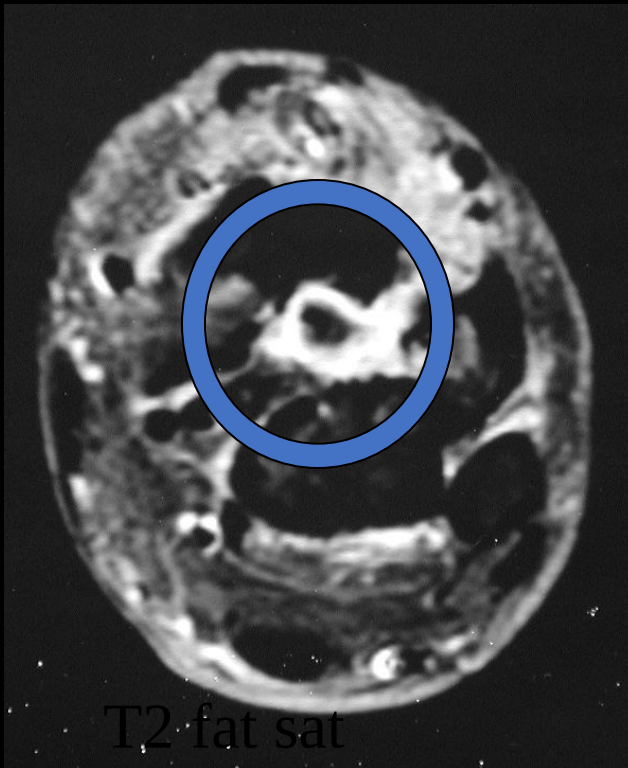
Complex fluid signal or
poorly defined
edema in marrow
without
enhancement

Surgically proven
necrotic iliac wing



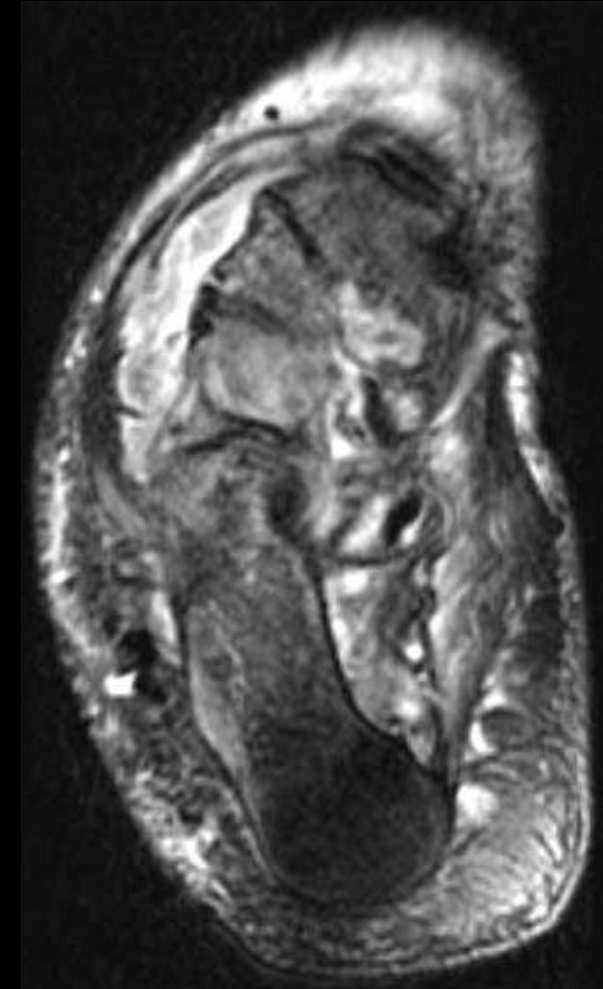
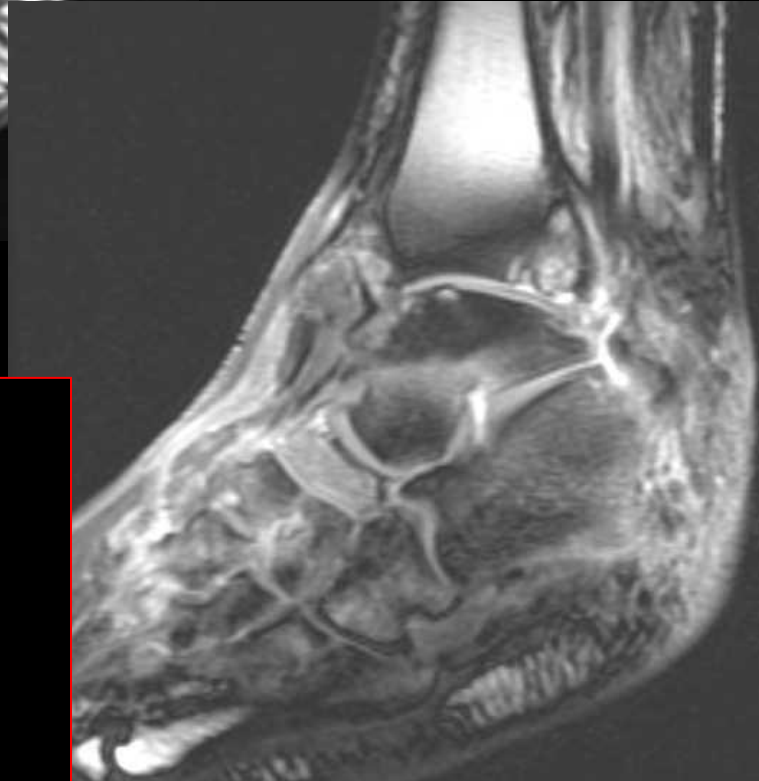
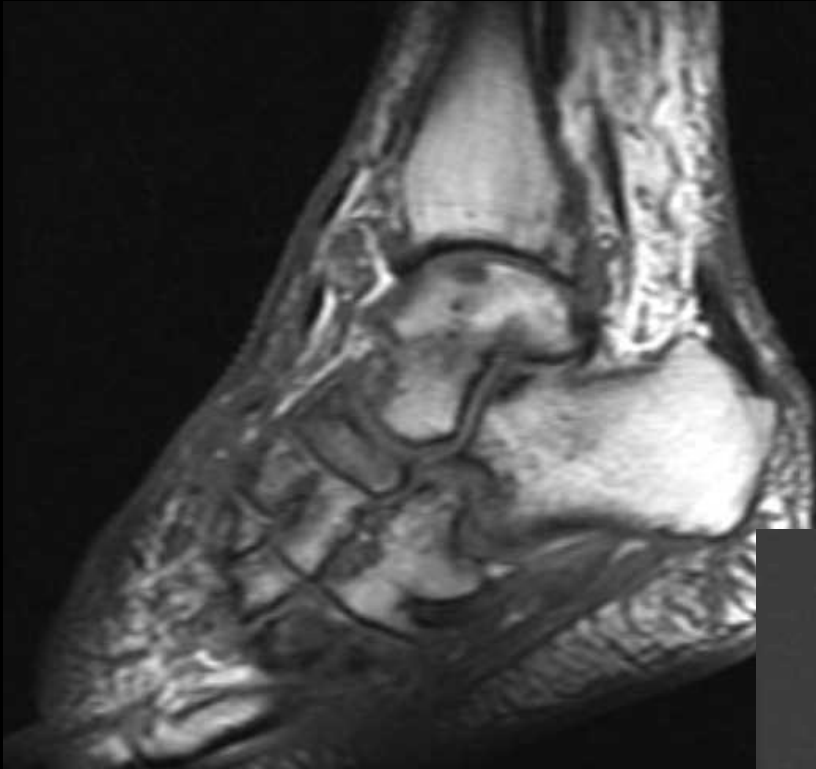
Sequestrum at MRI: *Chronic Osteomyelitis*

Focal low signal
surrounded by
enhancing marrow



Surgically proven

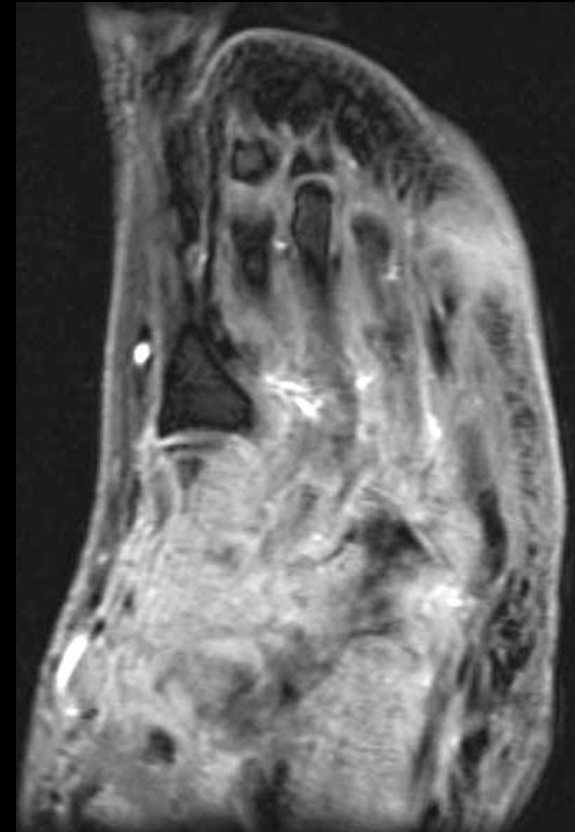
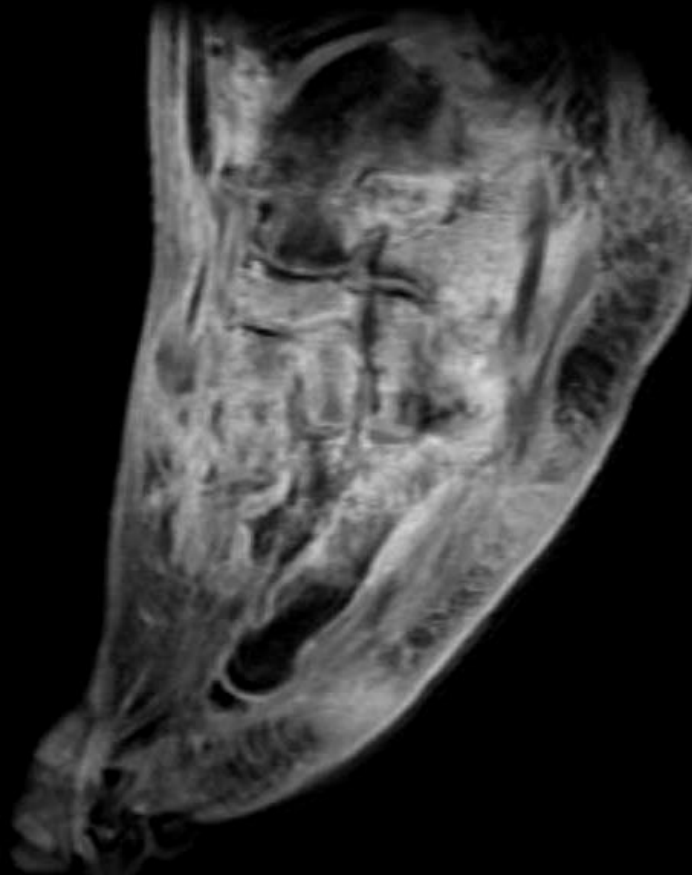
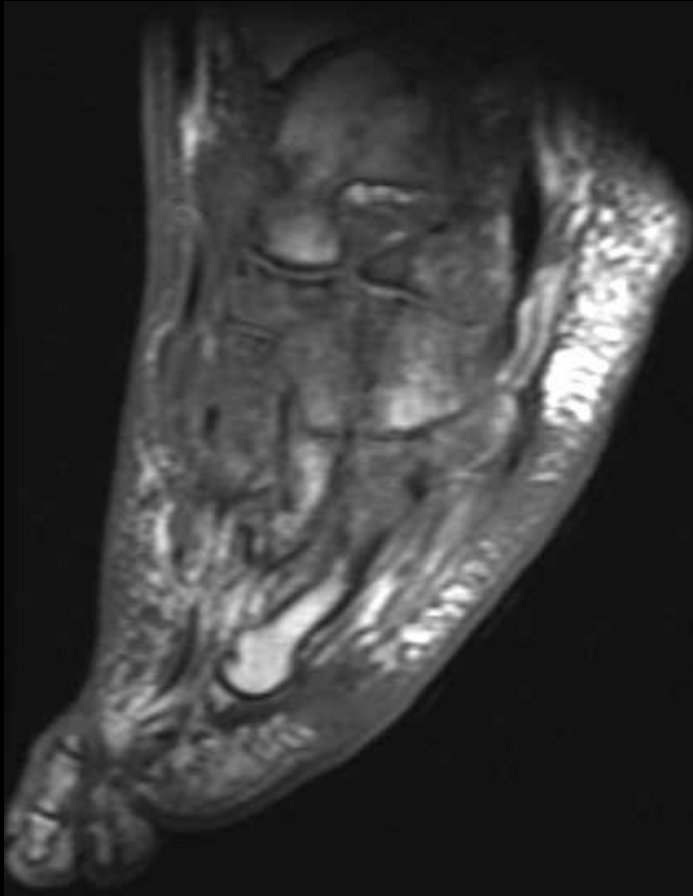
Diabetic Pedal Osteomyelitis and Neuropathic Arthritis



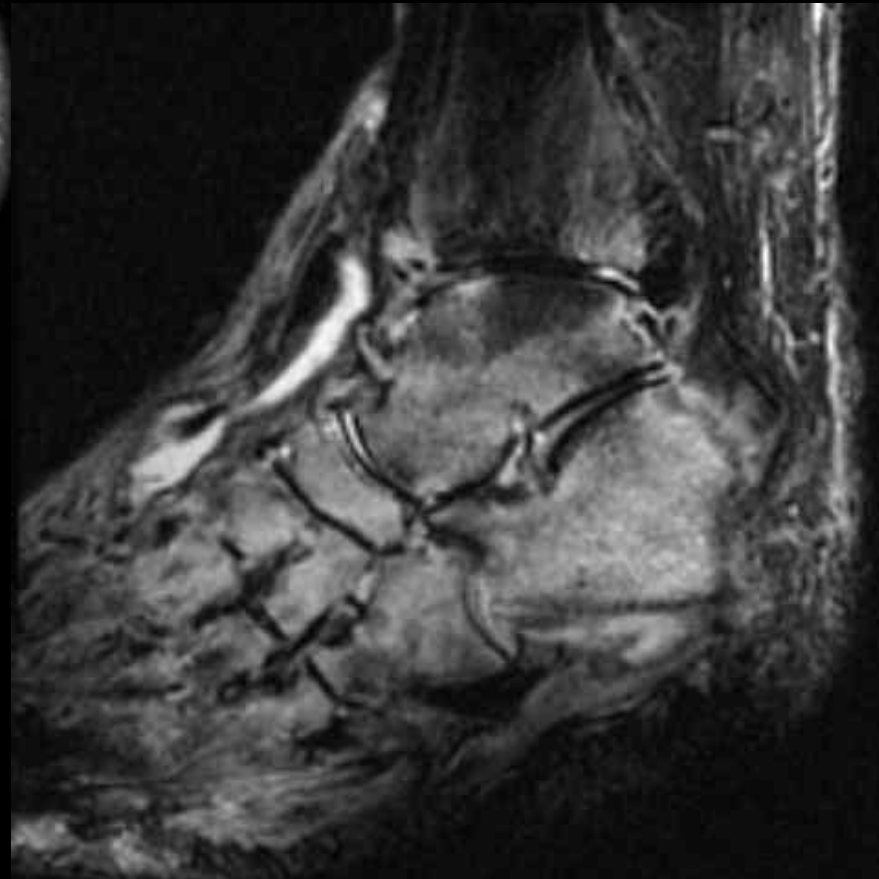
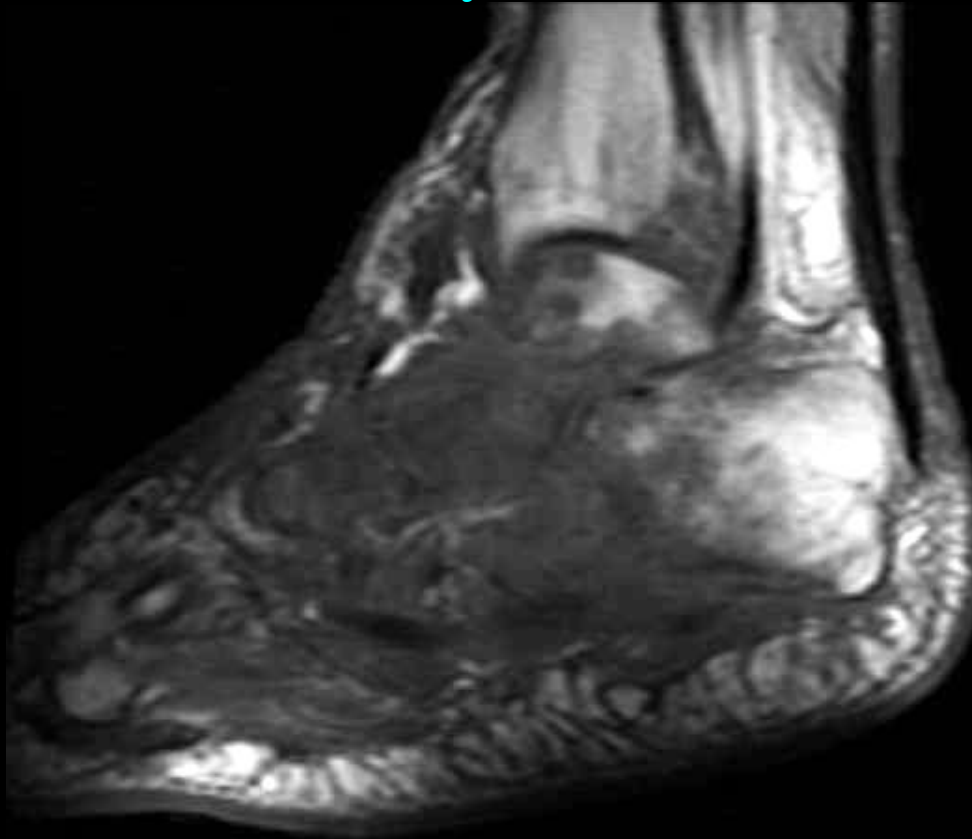
*T1 signal may be
Preserved early on*

*Look for continuity with skin
defect*

3 weeks later

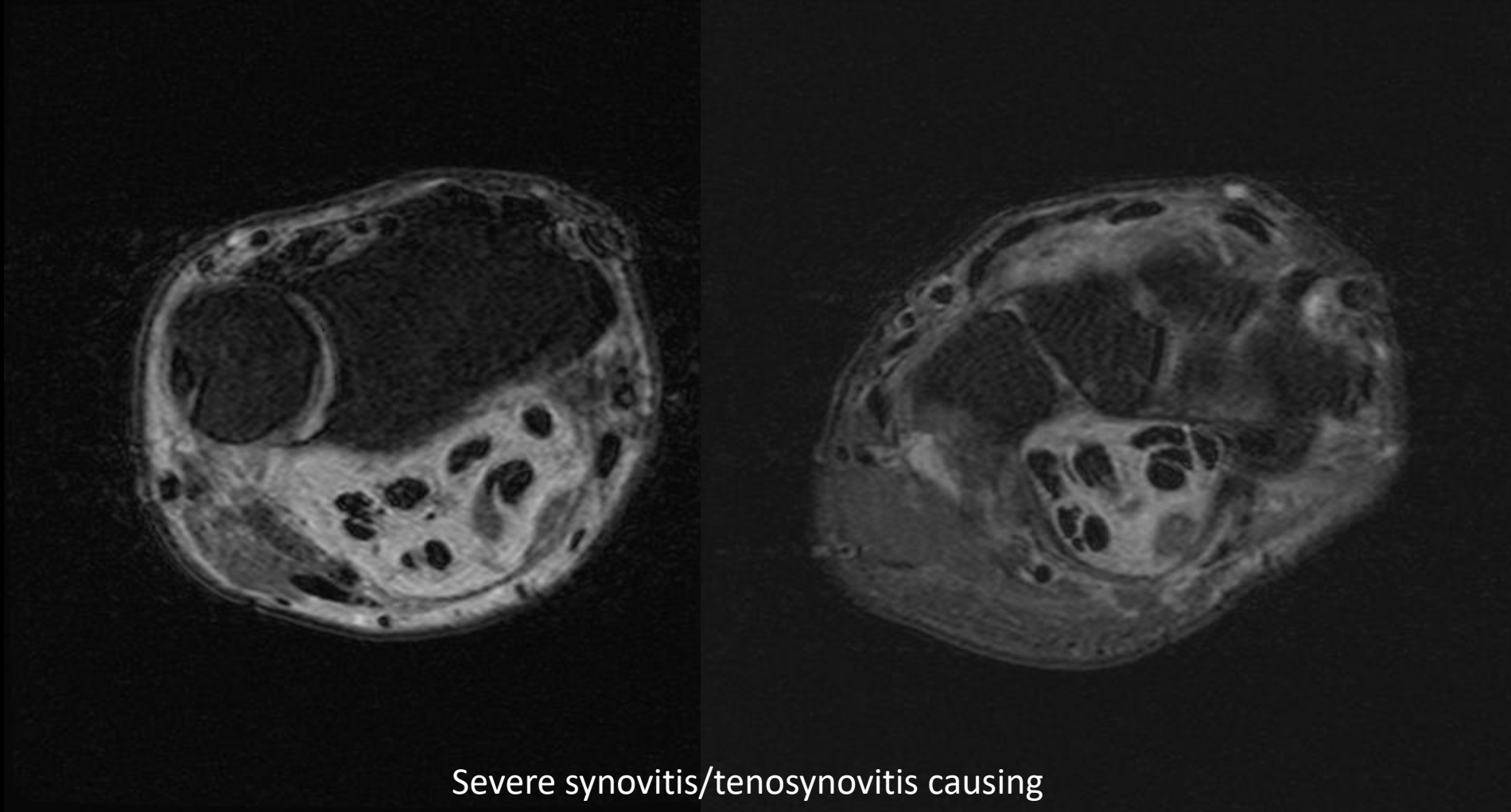


14 more days

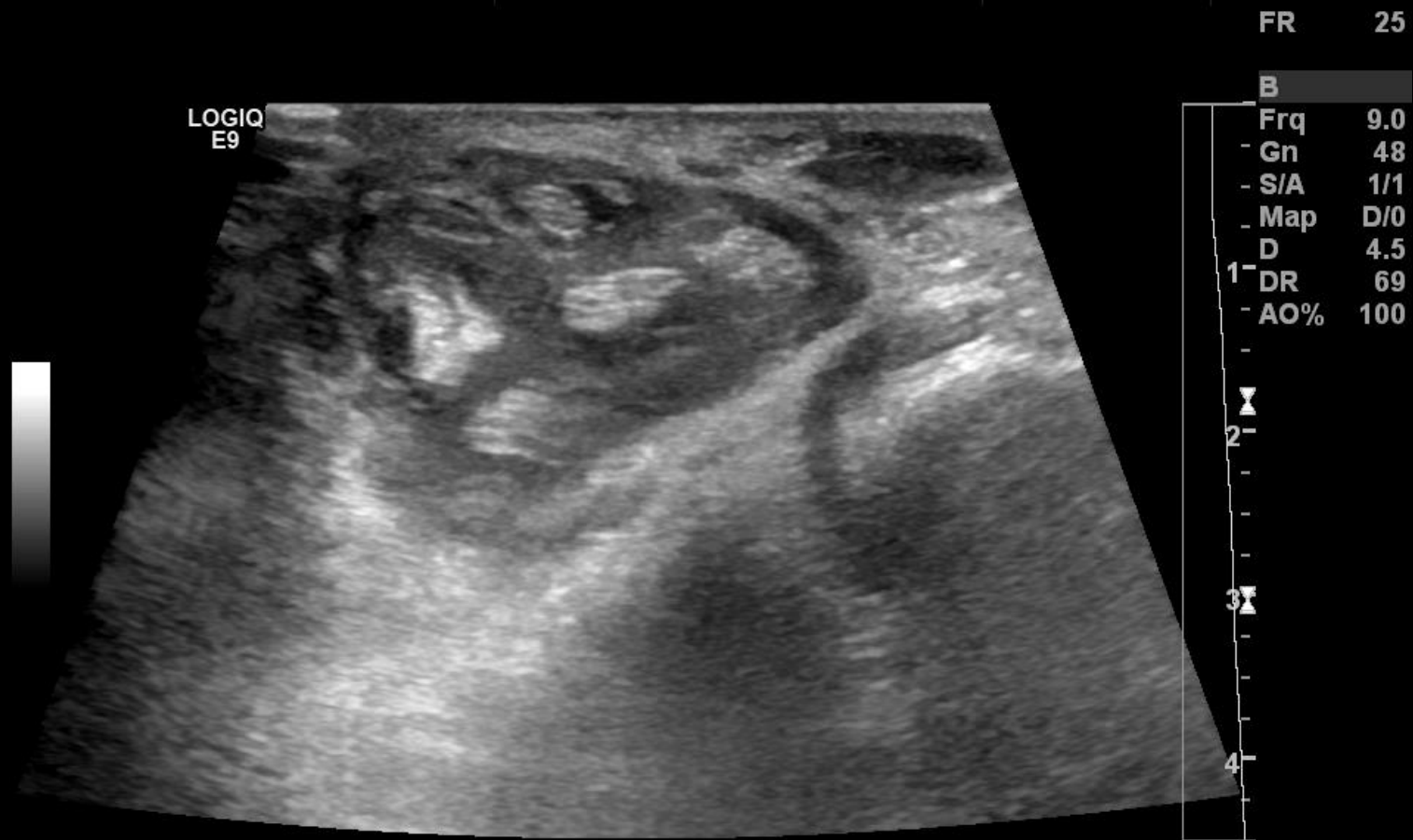


Atypical MSK Infections

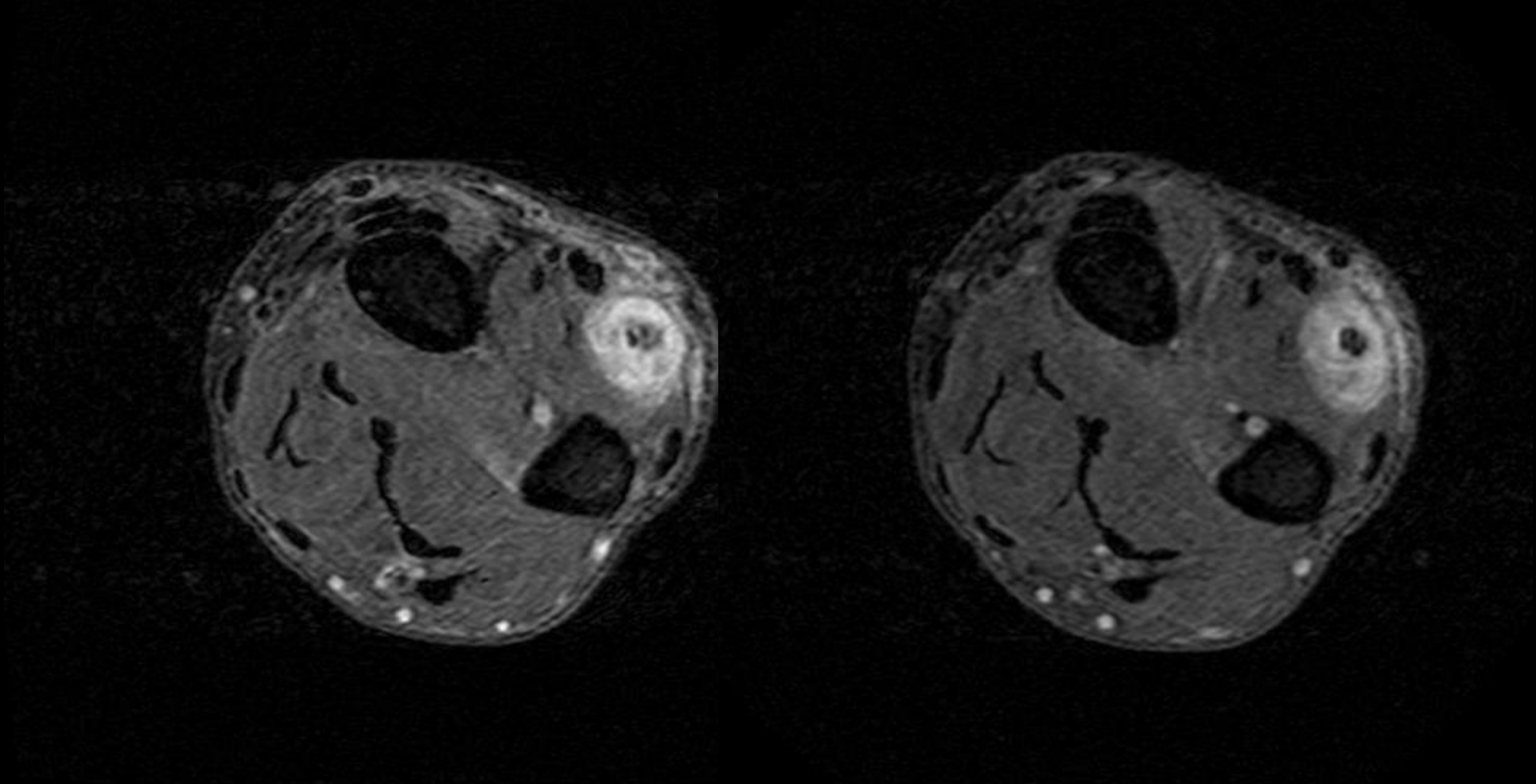
52 year old with atypical multijoint inflammatory



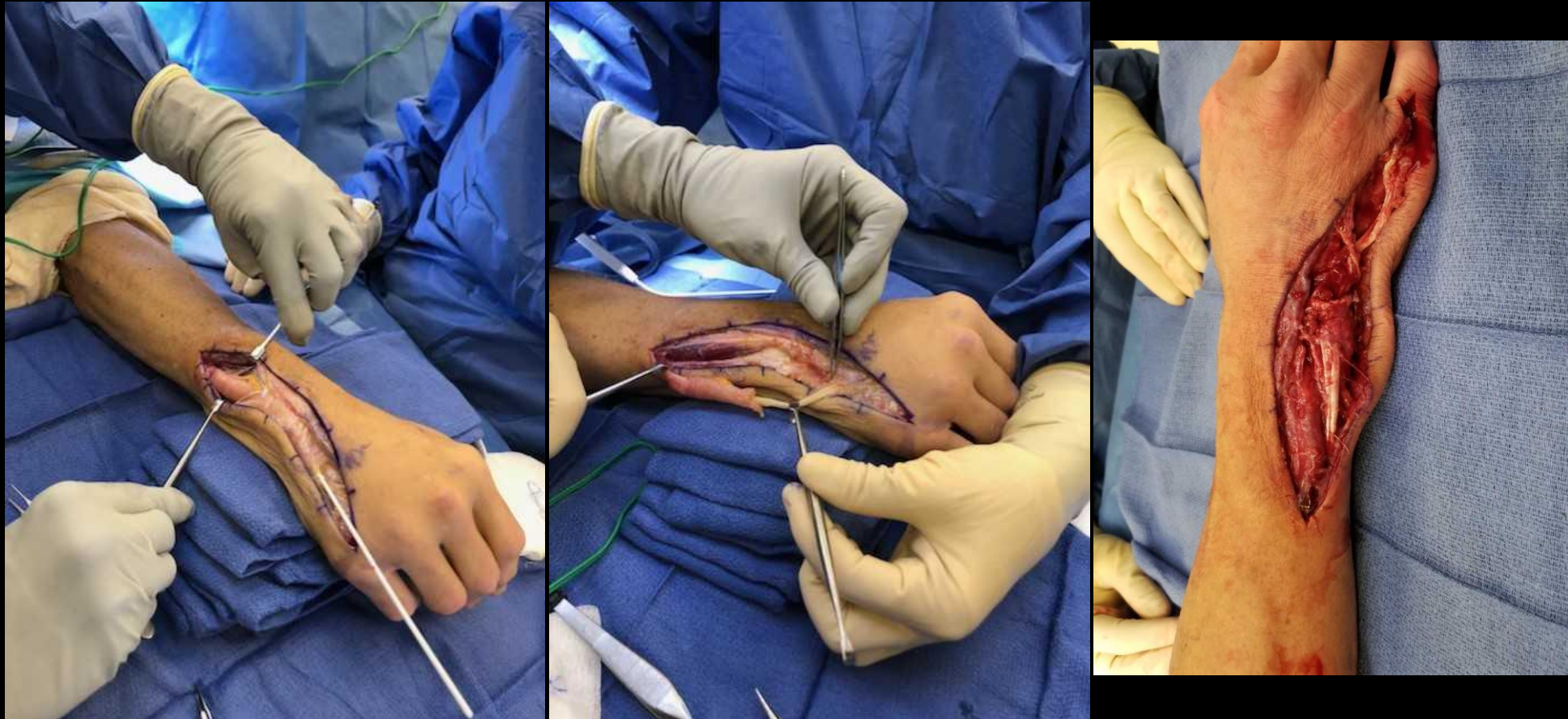
Severe synovitis/tenosynovitis causing
carpal tunnel syndrome



RIGHT WRIST FLEXOR



9 months post procedure, weakness localized to
extensor digiti minimi



Frank mycobacterium marinum resected from
extensor digiti minimi tendon sheath

Mycobacterial

- immunocompromised patients
 - atypical species
 - drug resistant strains
-
- spine most common site (25-60%)
 - spine: T/L junction most common
 - most have infection elsewhere also (pulm / GU)

Contiguous Spread:
non-diabetic

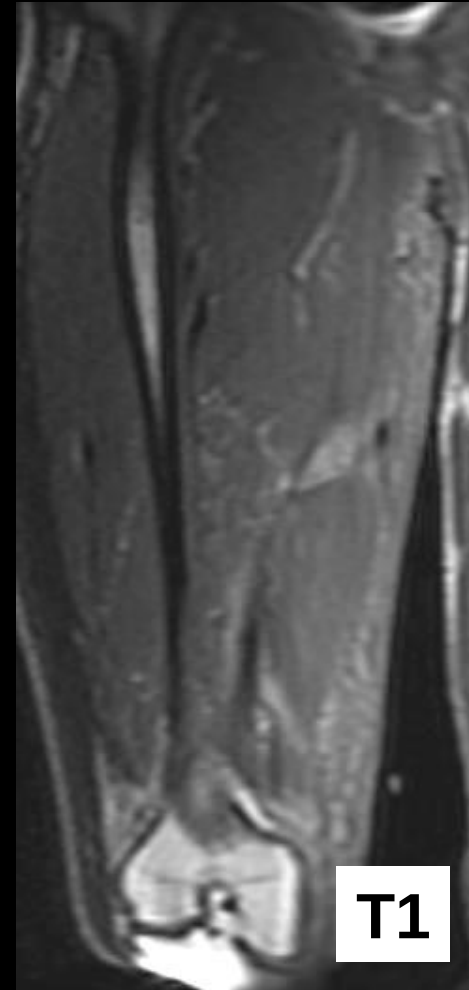


Group B Streptococcus
“Flesh-eating bacteria”

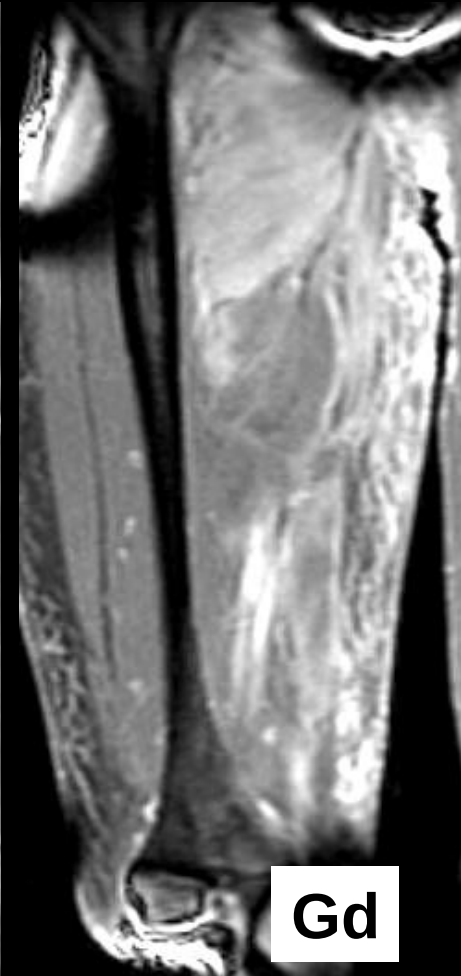
STIR



HIV+ Patient



T1

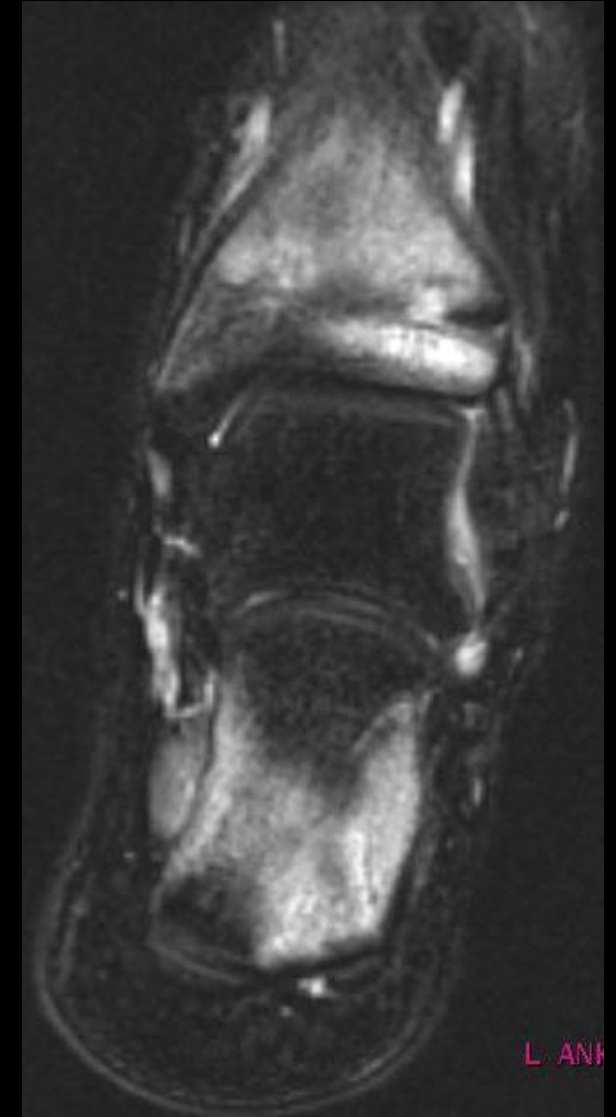
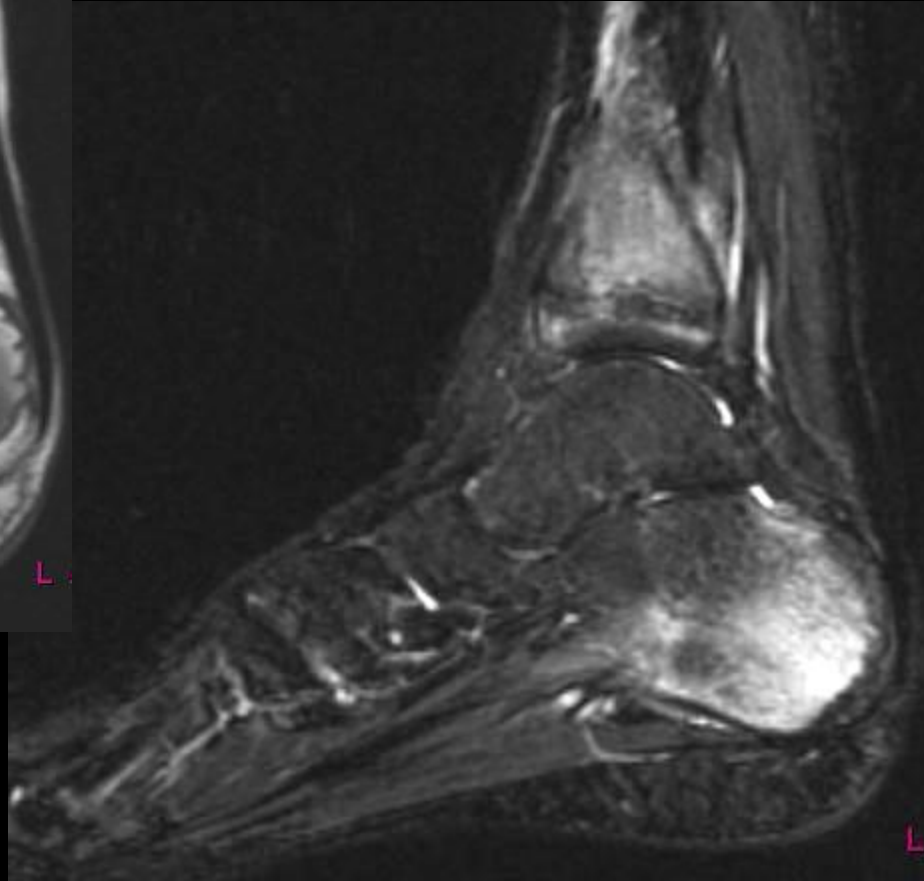


Gd

Candida pyomyositis

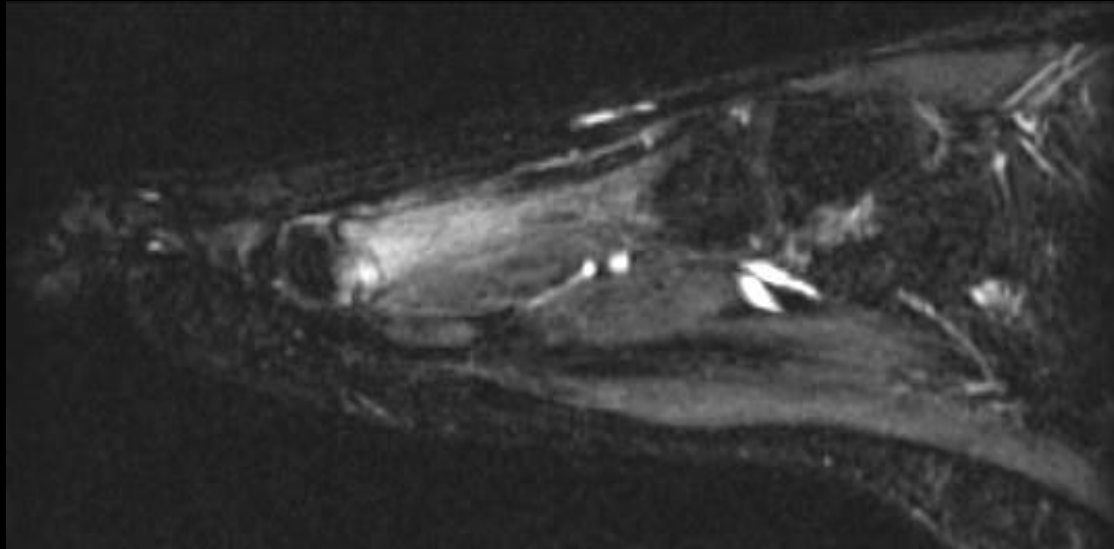


Jefferson



Chronic Recurrent Multifocal Osteomyelitis

CRMO/CNO

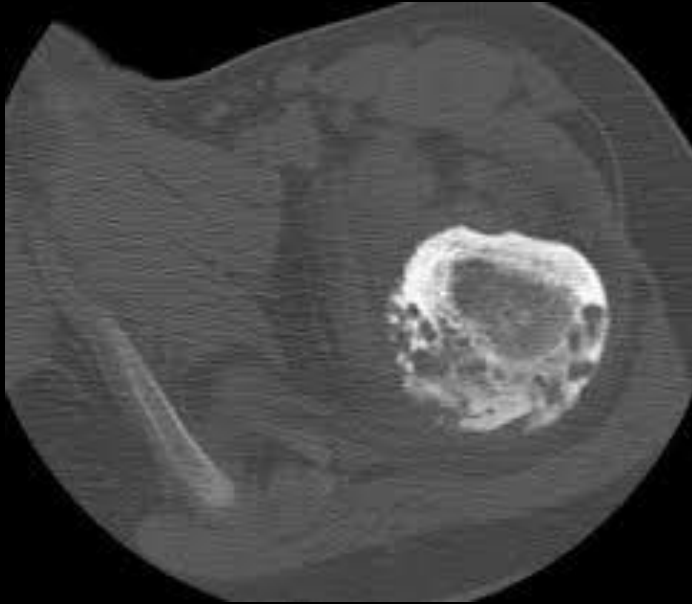


Relapsing infection
Possibly viral
Immunosuppression likely



Chronic Recurrent Osteomyelitis / Chronic Noninfectious Osteitis

26 year old 3 femur biopsies with C/S yielding lymphocytes and plasma cells



1: Probst FP, Björkstén B, Gustavson KH. Radiological aspect of chronic recurrent multifocal osteomyelitis. *Ann Radiol (Paris)*. 1978 Mar-Apr;21(2-3):115-25. English, French. PubMed PMID: 677736.

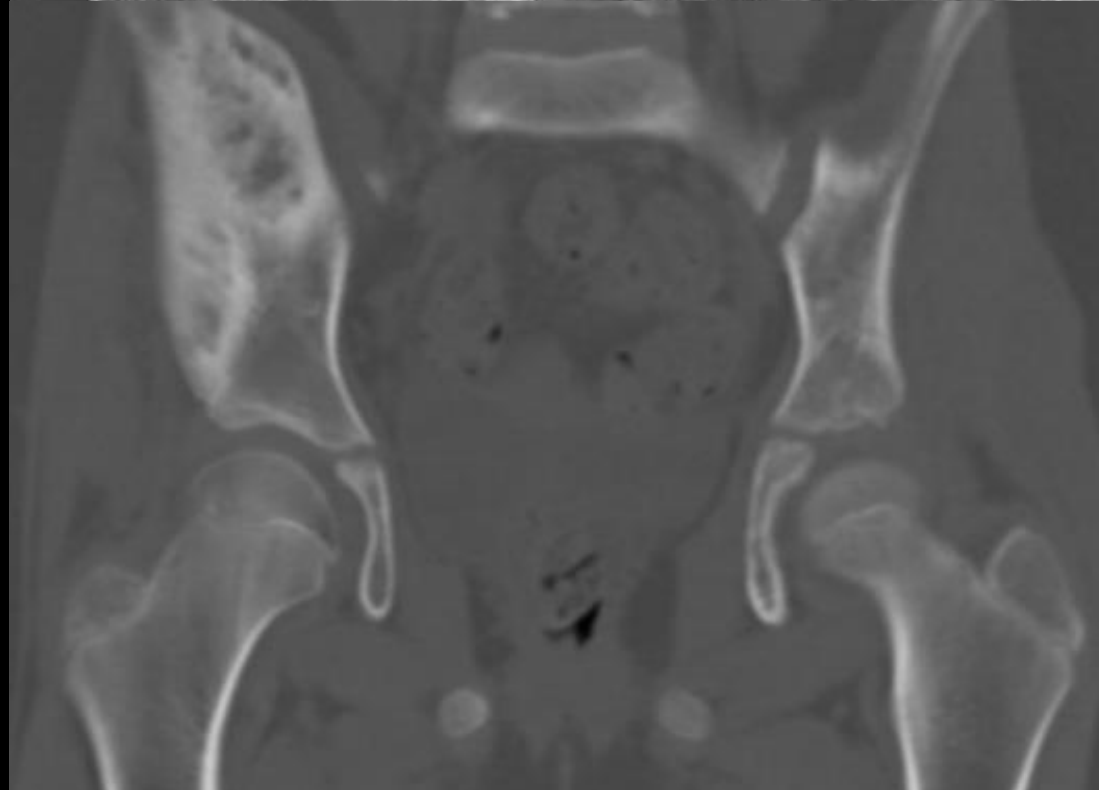
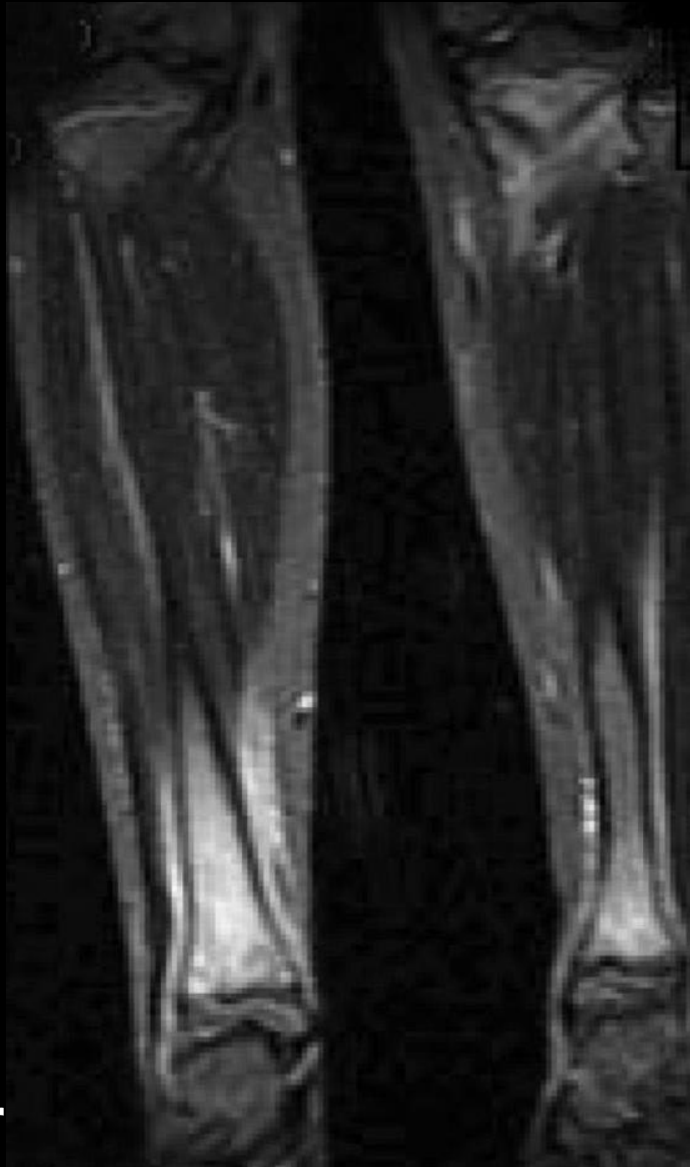
2: Björkstén B, Boquist L. Histopathological aspects of chronic recurrent multifocal osteomyelitis. *J Bone Joint Surg Br*. 1980 Aug;62(3):376-80. PubMed PMID: 7410472.

3: Cyrlak D, Pais MJ. Chronic recurrent multifocal osteomyelitis. *Skeletal Radiol*. 1986;15(1):32-9. PubMed PMID: 3941921.

4: Brown T, Wilkinson RH. Chronic recurrent multifocal osteomyelitis. *Radiology*. 1988 Feb;166(2):493-6. PubMed PMID: 3336727.

5: Rosenberg ZS, Shankman S, Klein M, Lehman W. Chronic recurrent multifocal osteomyelitis. *AJR Am J Roentgenol*. 1988 Jul;151(1):142-4. PubMed PMID: 3259798.

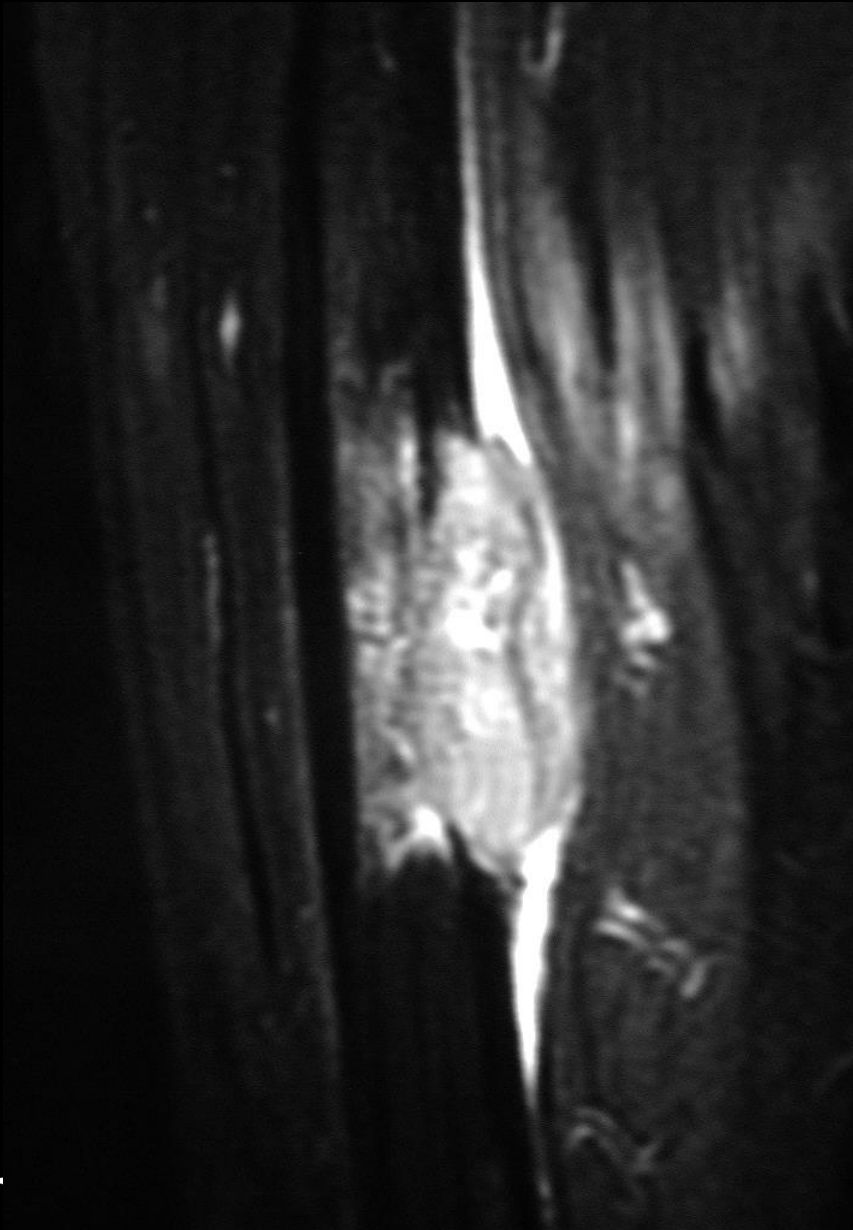
CRMO/CNO Imaging



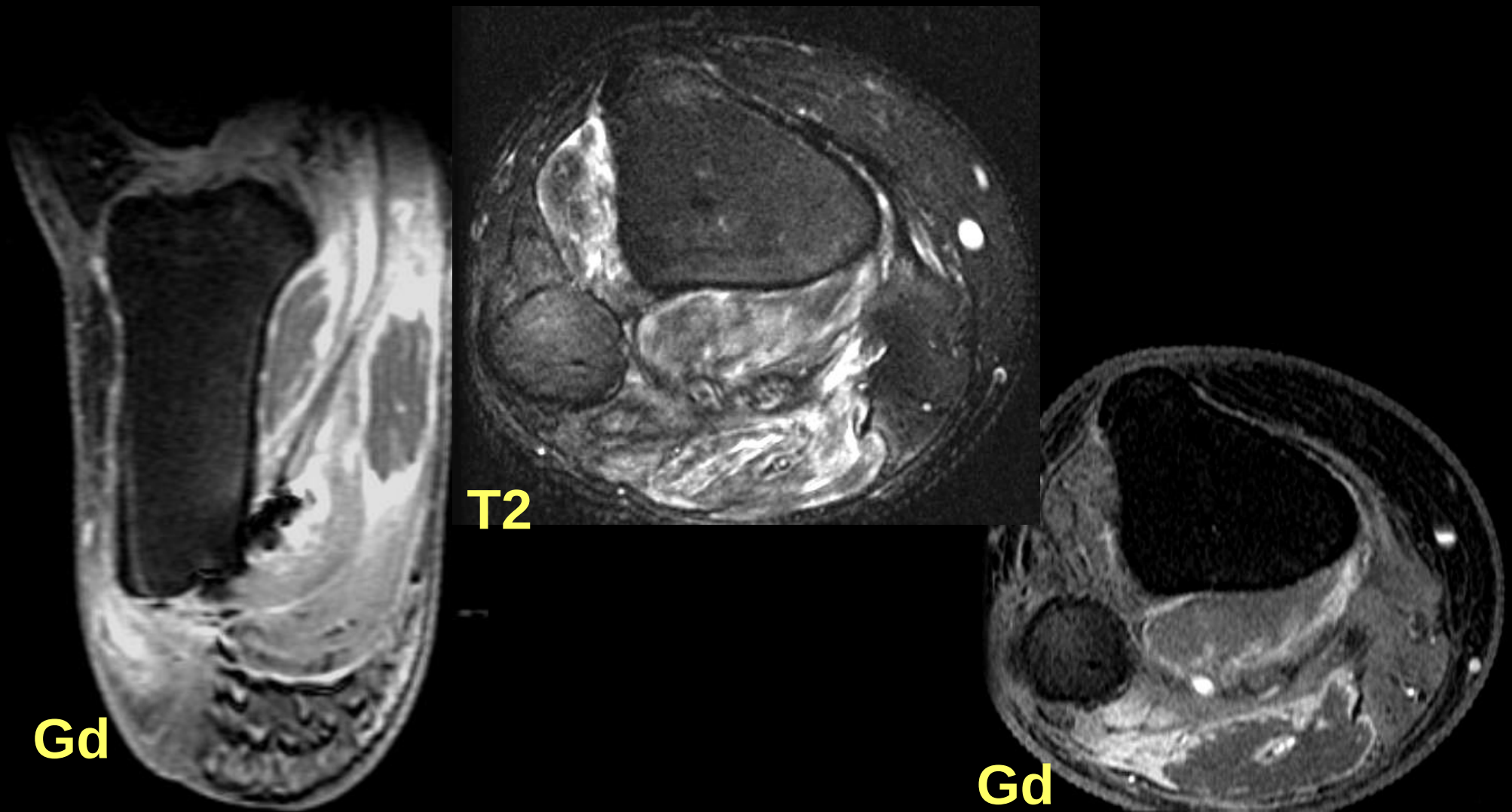
MR Mimickers of Infection

- Tumor
- Necrosis / infarction
- Myositis ossificans
- Inflammatory Arthropathy

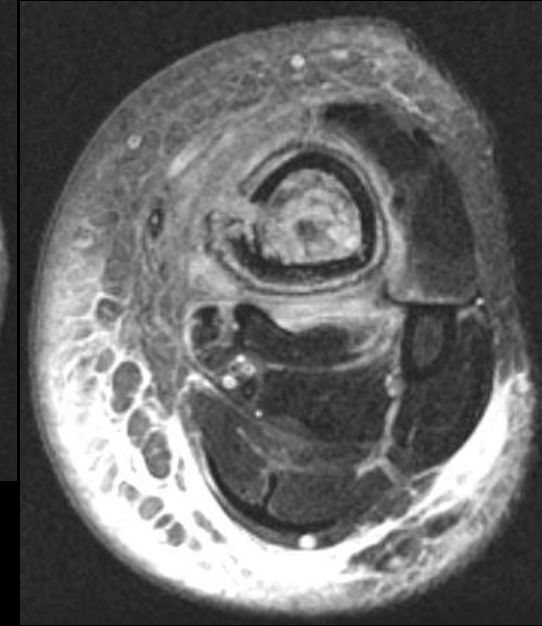
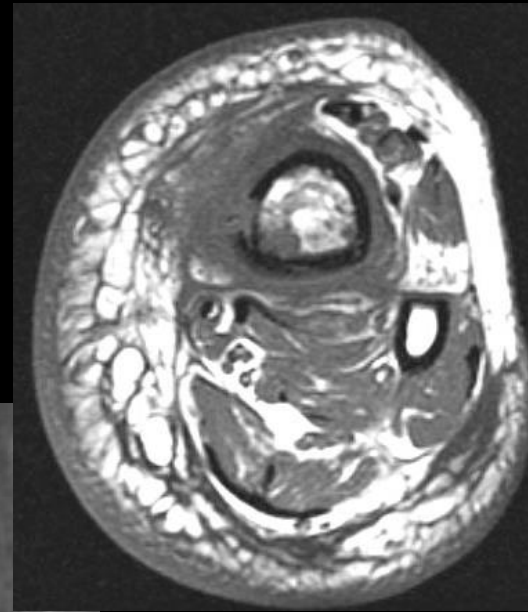
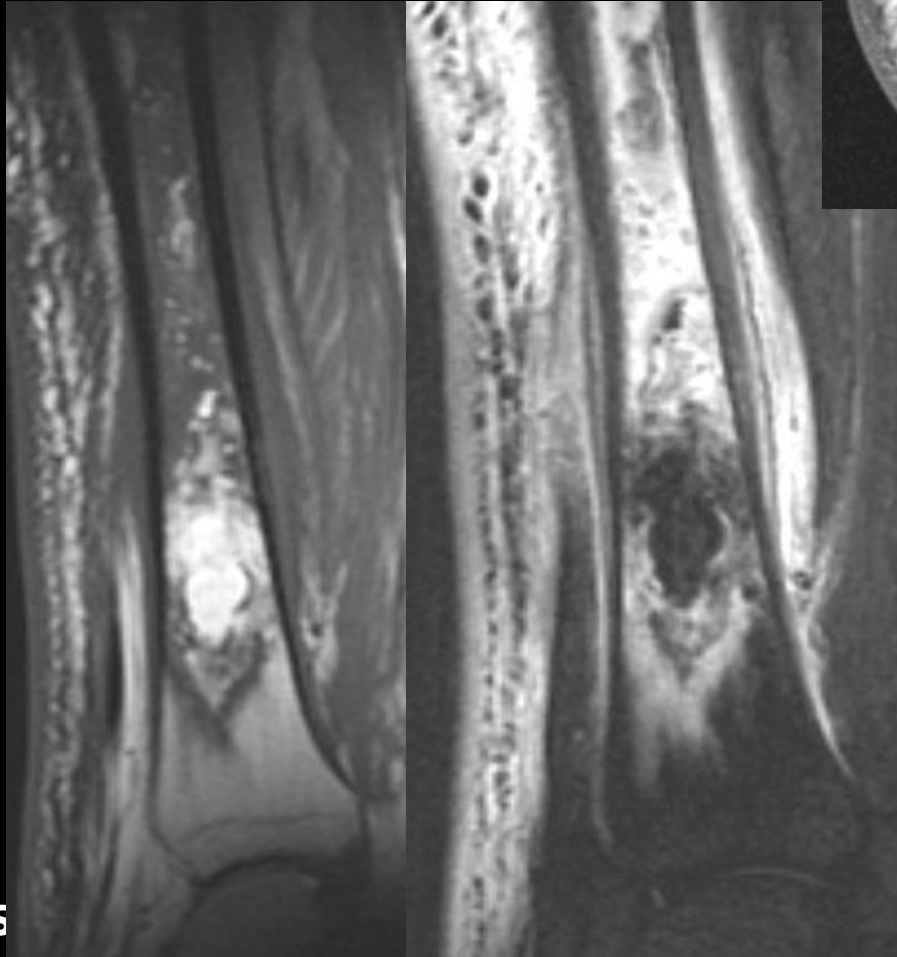
Metastasis



Necrosis of Muscle Flap



Osteomyelitis + Infarct



**Synovial
Sarcoma**



Organized hematoma

Pleomorphic Sarcoma

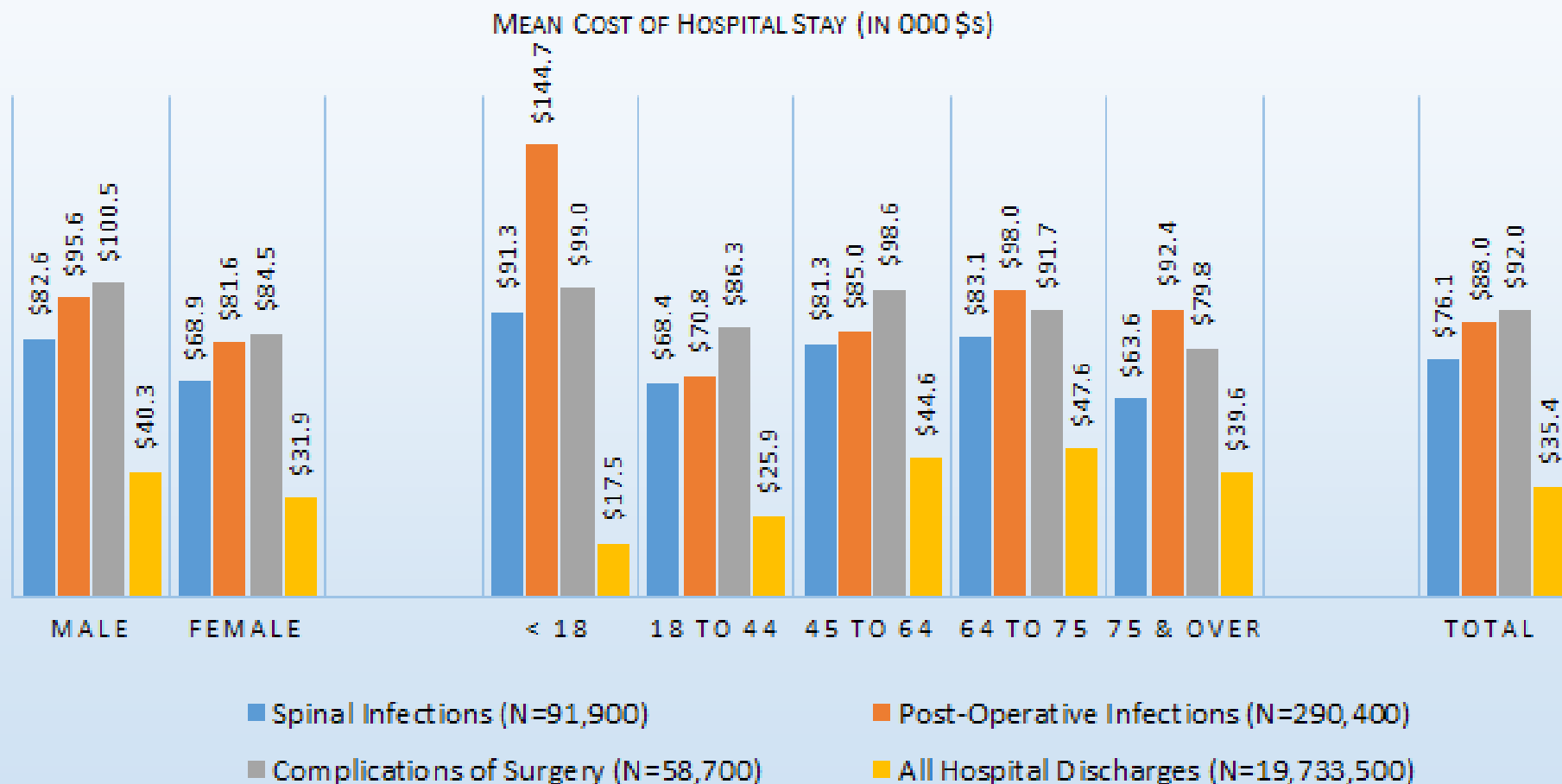


Infection of the Spine

- Paraspinal / epidural abscess
- Spinal column
 - Discitis / osteomyelitis: “infectious spondylitis”
- DDx, non-infectious inflammatory conditions



Mean Hospital Charges for Spinal Infection, Post-Operative Infection, Complications of Surgery, and All Hospital Discharges, by Age and Sex, United States 2011



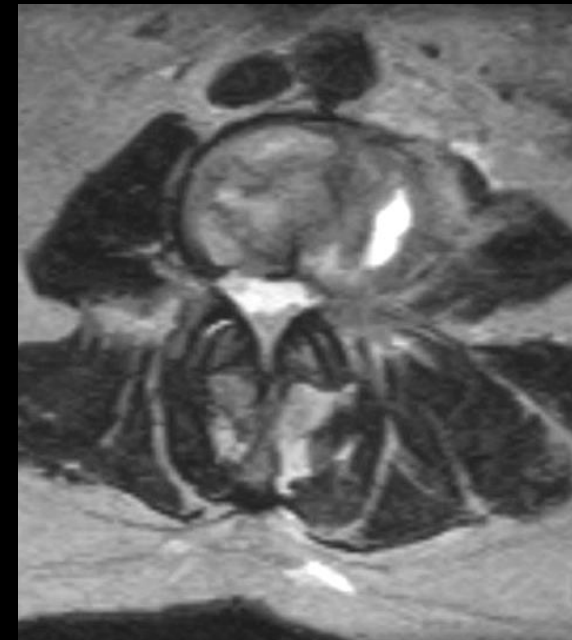
Source: HCUP Nationwide Inpatient Sample (NIS). Healthcare Cost and Utilization Project (HCUP). 2011. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/nisoverview.jsp

File: G3C.3.0





Early septic discitis



Routes of Spread



- Hematogenous
- Contiguous spread
- Direct implantation



Hematogenous spread

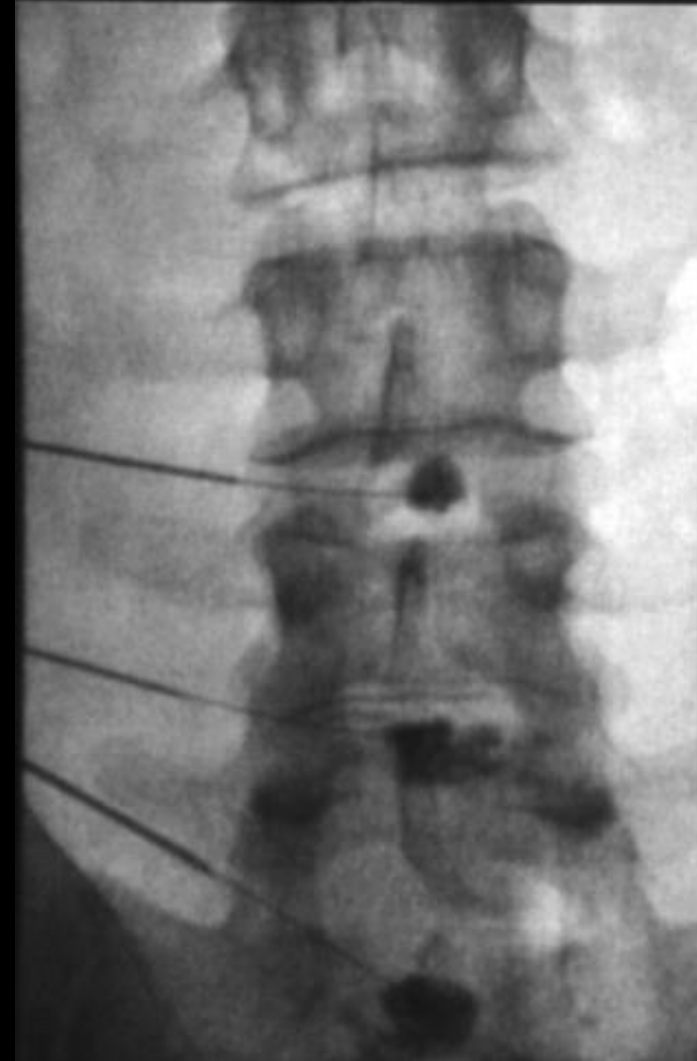
- Infection most often begins near endplate
- Adjacent disc avascular
- Disc not thought to be a common site of implantation
 - exceptions
 - *infants -> adolescents - penetrating vessels*
 - *degen disc disease - revascularization of disc*

39 year old mitral valve endocarditis

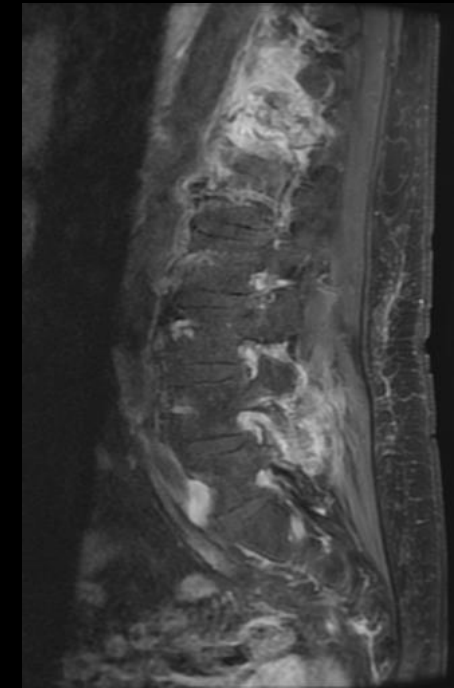
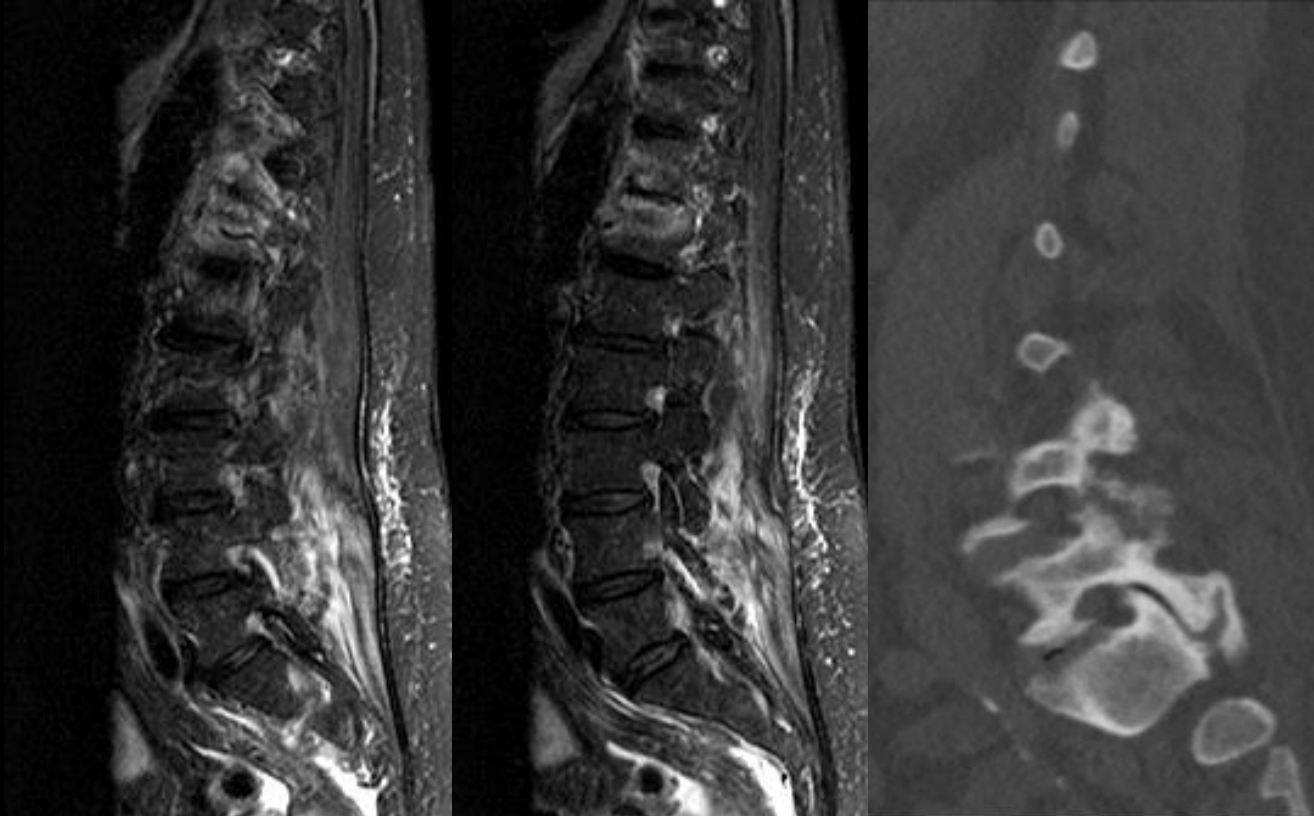


Direct Implantation of Infection

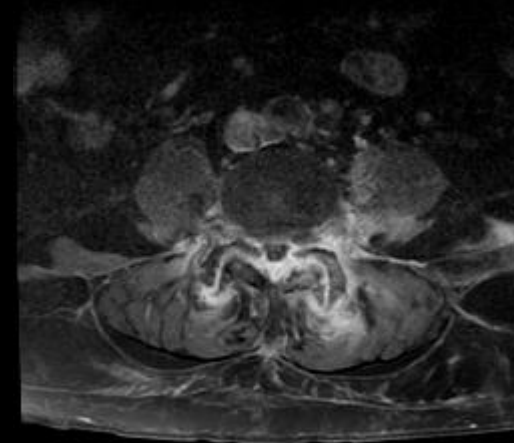
- biopsy
- discography
- unintentional disc penetration
- discectomy, fixation/fusion
- Penetrating trauma



56 year old post L4-L5 epidural steroid injection



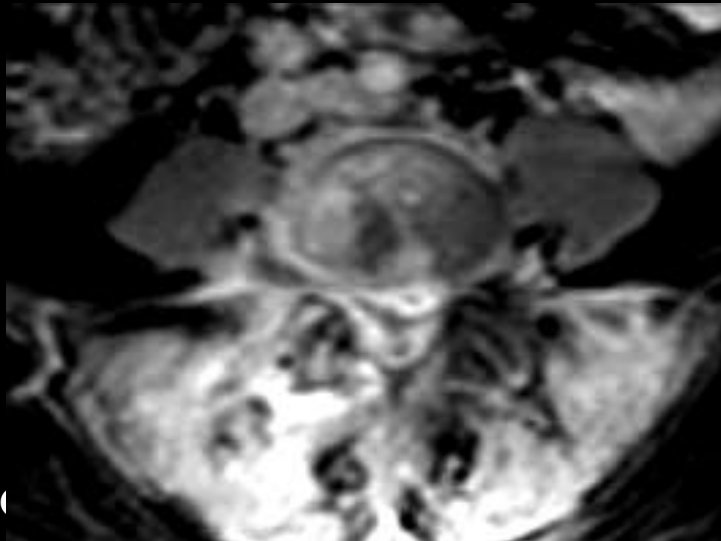
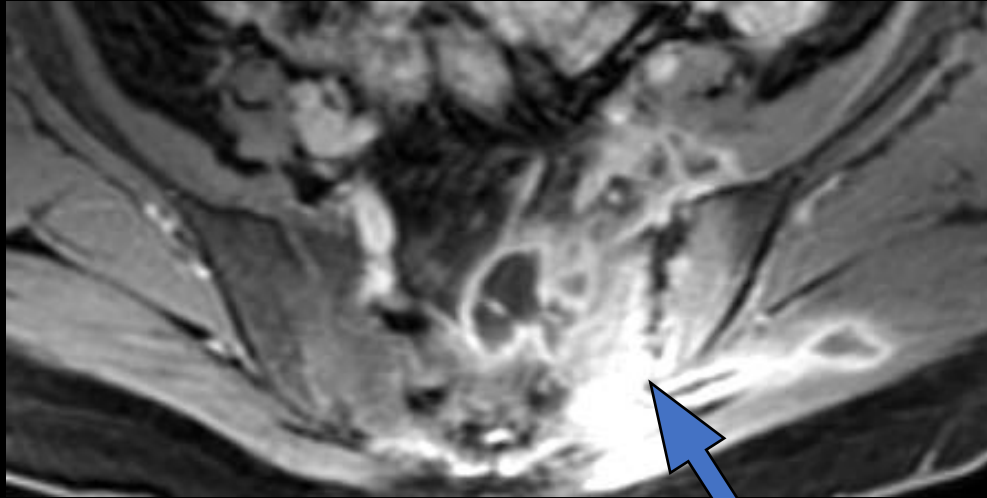
Post Gd



Contiguous spread

- Paraspinal infection
 - uncommon source of vertebral osteomyelitis, but common cause of spread to multiple levels, esp in TB, fungal infections

Contiguous spread



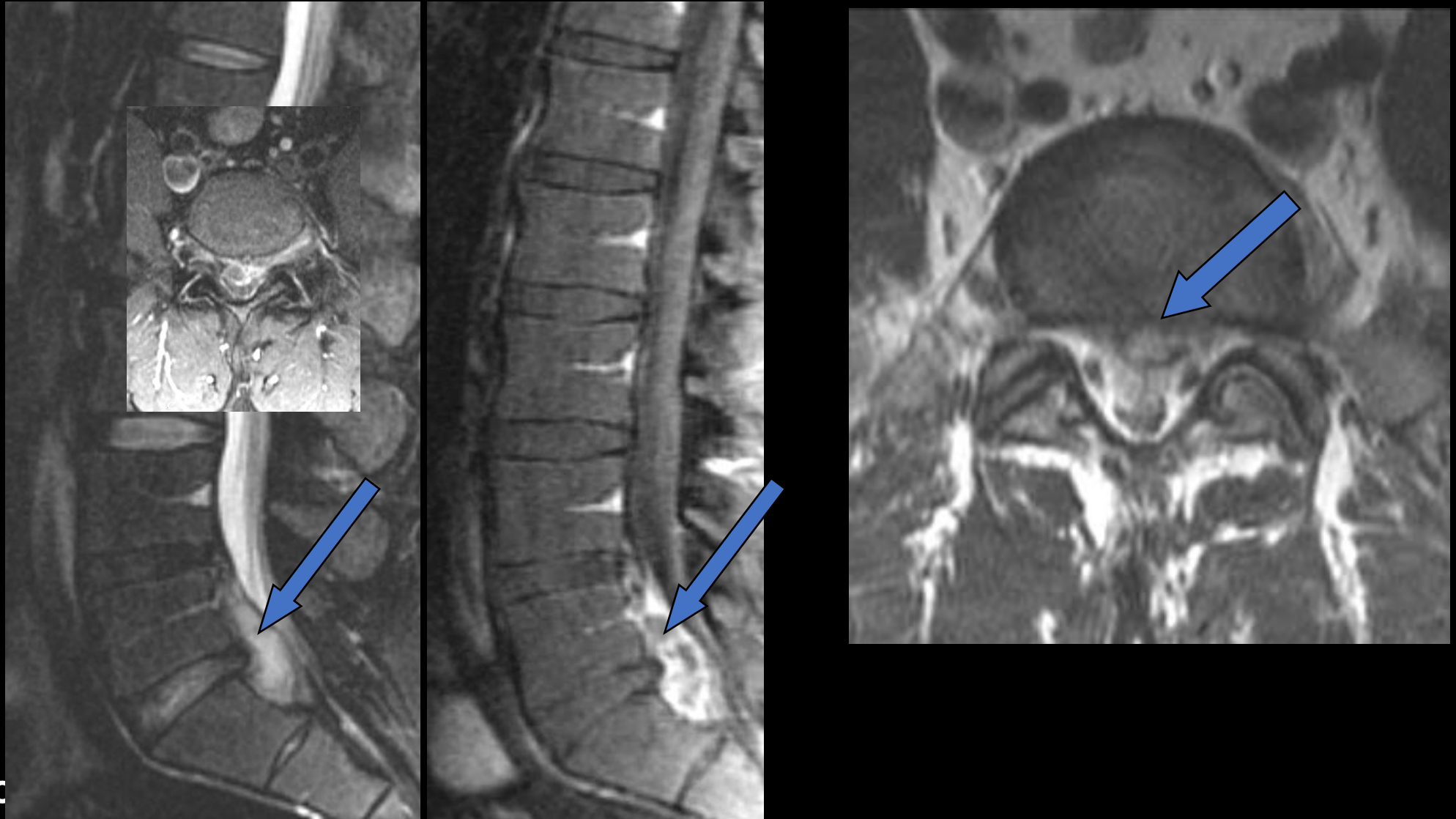
Paraspinal / Epidural Abscess

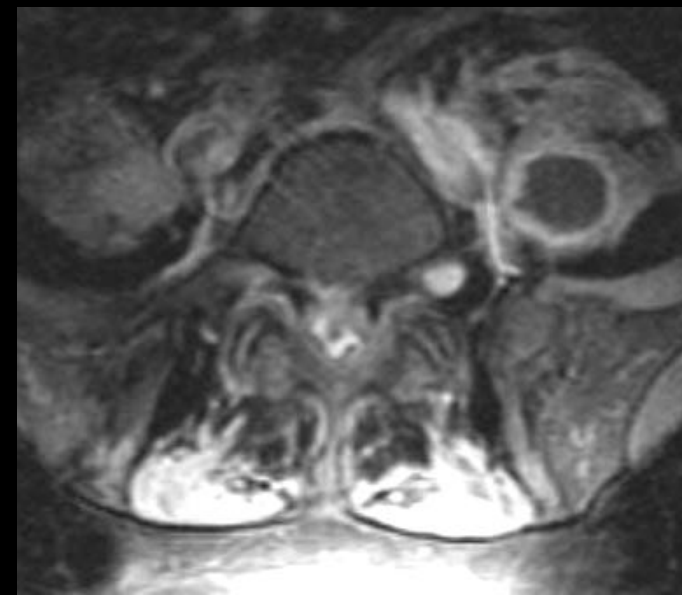
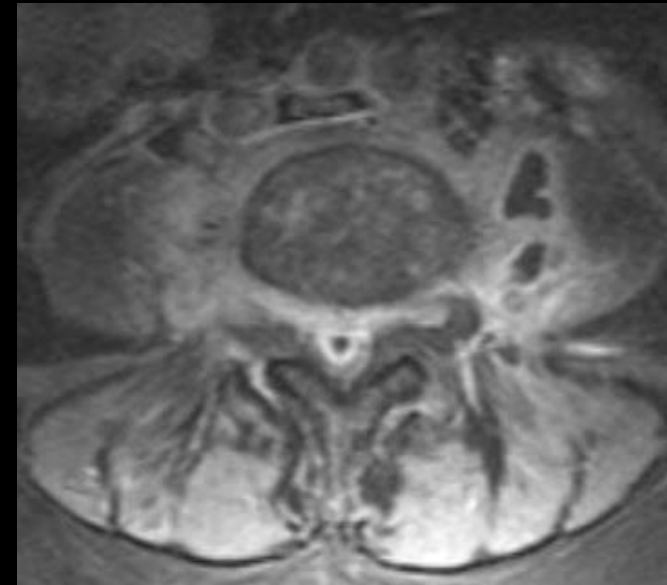
- may occur primarily, but more commonly secondary to spread from infected disc/vertebra
- extends along fascial planes sup/inf
- epidural abscess - spinal stenosis, nerve root / cord compression

Imaging of Epidural Abscess

- MRI - primary method for diagnosis
 - *paraspinal / epidural edema, fluid signal, may be complex with septations, loculations*
 - *Gd-enhancement with thick, irregular rim-enhancement*
 - *usu associated with discitis / osteomyelitis (but approx. 30% WITHOUT disc infection)*

Epidural Abscess





Discitis / Osteomyelitis

- Bacterial - most common
 - **S. aureus**, Strep species, pneumococcus, pseudomonas, E. coli, Klebsiella
- L-spine > T-spine > C-spine
- Recent h/o infection elsewhere is common, c/w hematogenous spread

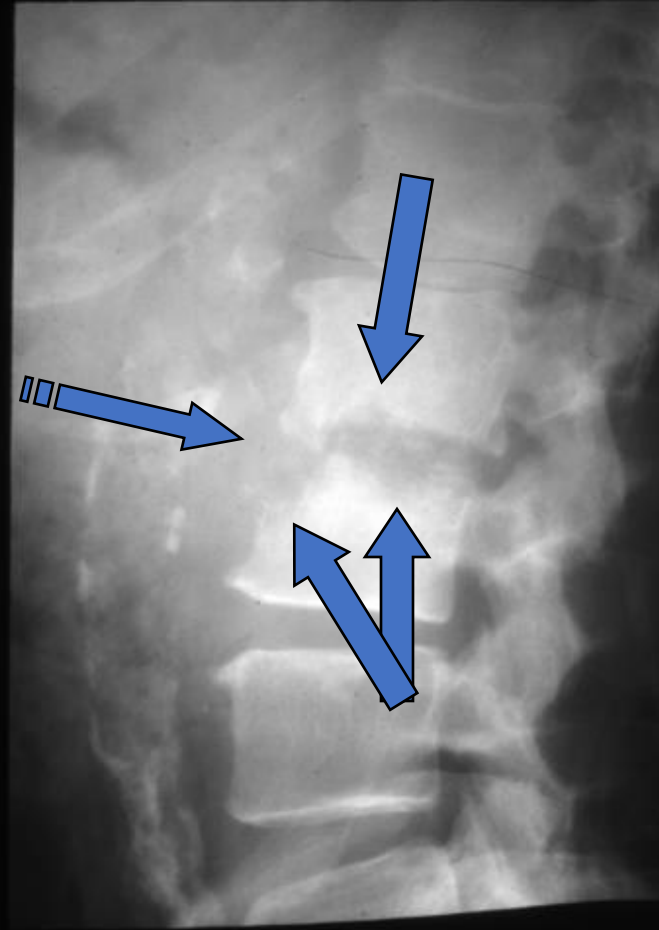
Imaging of Infectious Spondylitis

- Radiography
 - Early findings
 - disc narrowing
 - paraspinal soft tissue mass effect
 - endplate irregularity
 - Late findings
 - endplate destruction
 - deformity
 - sclerosis

Discitis / Osteomyelitis



Pre-discitis

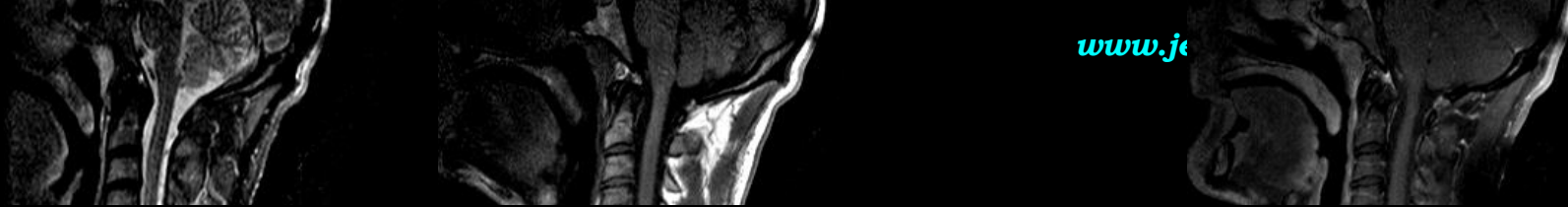


Post-discitis

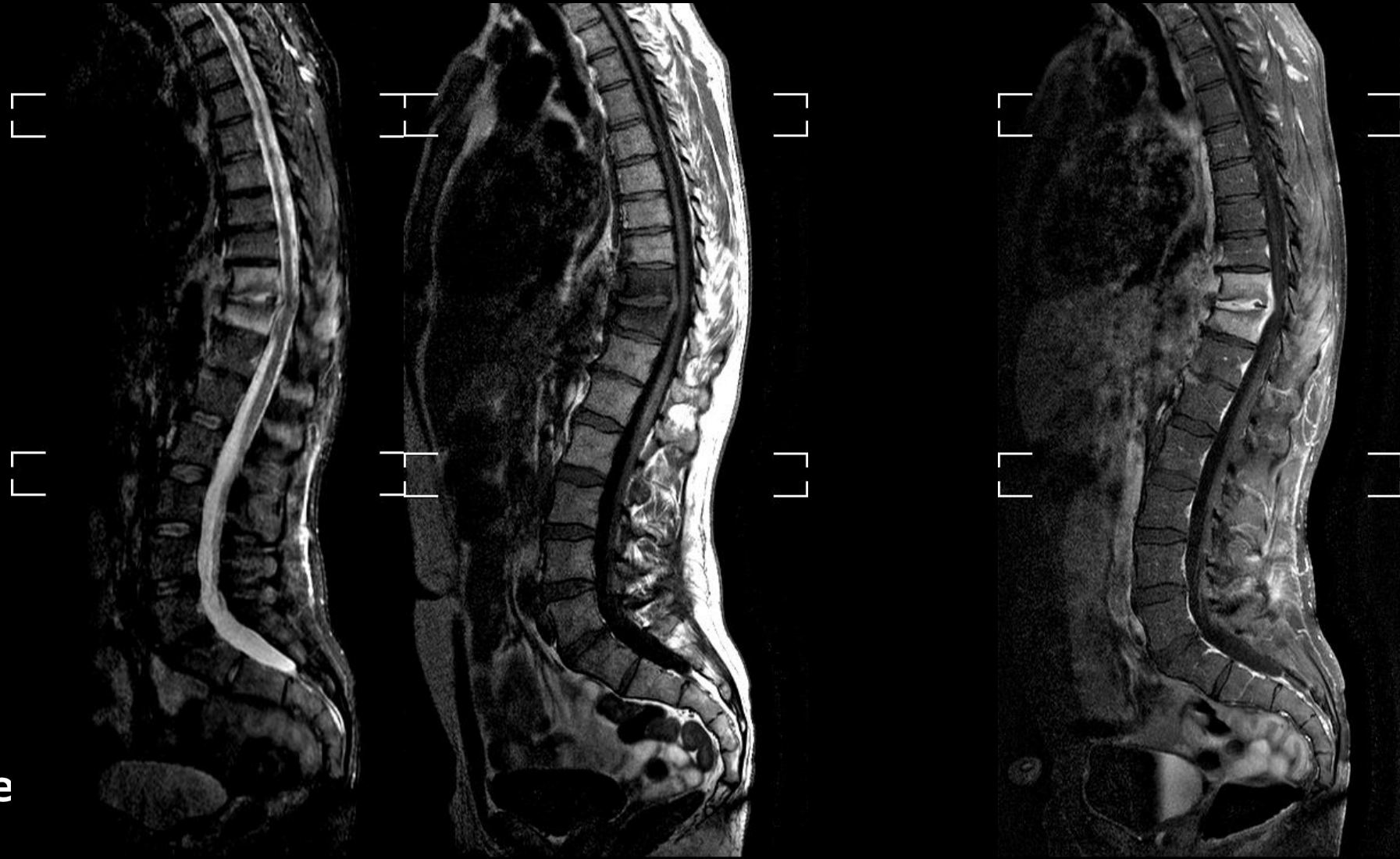
Imaging of Infectious Spondylitis

- CT
 - Same osseous findings as radiographs
 - Loss of endplate cortex
 - Disc space narrowing
 - Paraspinal / psoas inflammation +/- fluid density
 - Often used for biopsy planning, not primary mode of dx
- MRI
 - *Fluid bright disc, edema/erosions at endplates*
 - *paraspinal edema, fluid collections may be complex with septations, loculations*
 - *Gd-enhancement with thick, irregular rim-enhancement*
 - *Seen in 98% of bx-proven cases of discitis / osteomyelitis**

*Ledermann / Carrino, Spinal infection: imaging rules or myths? Radiology



47 year old trauma transfer – mobi spine



Imaging of Infectious Spondylitis

- Tc-MDP / Ga-citrate / In-WBC
- Infection - increased uptake
- Tc - nonspecific
- Ga / In-WBC - incr. specificity
- Limited role in imaging algorithm
 - *low specificity*
 - *delay diagnosis*
 - *lack of anatomic information for surgical planning*
 - *can be useful if MRI contraindicated, or if radiographs negative - screening*

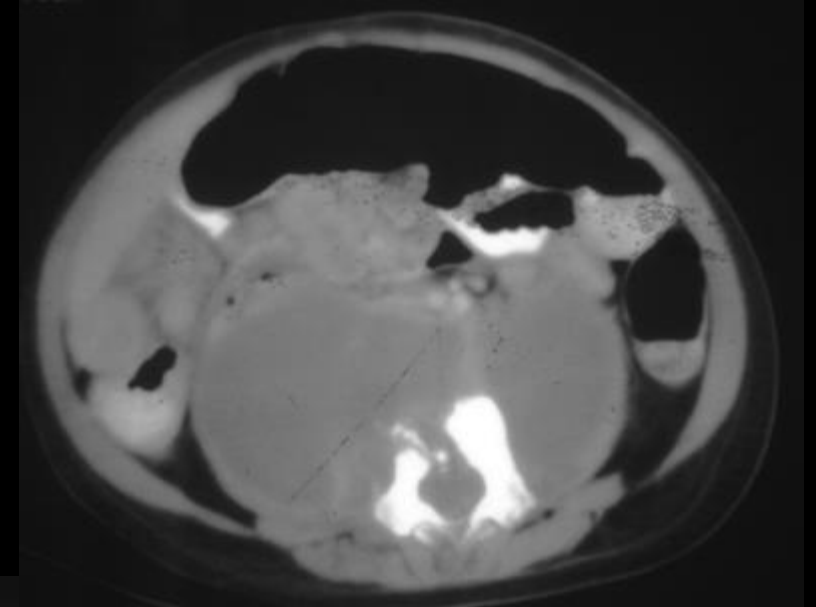
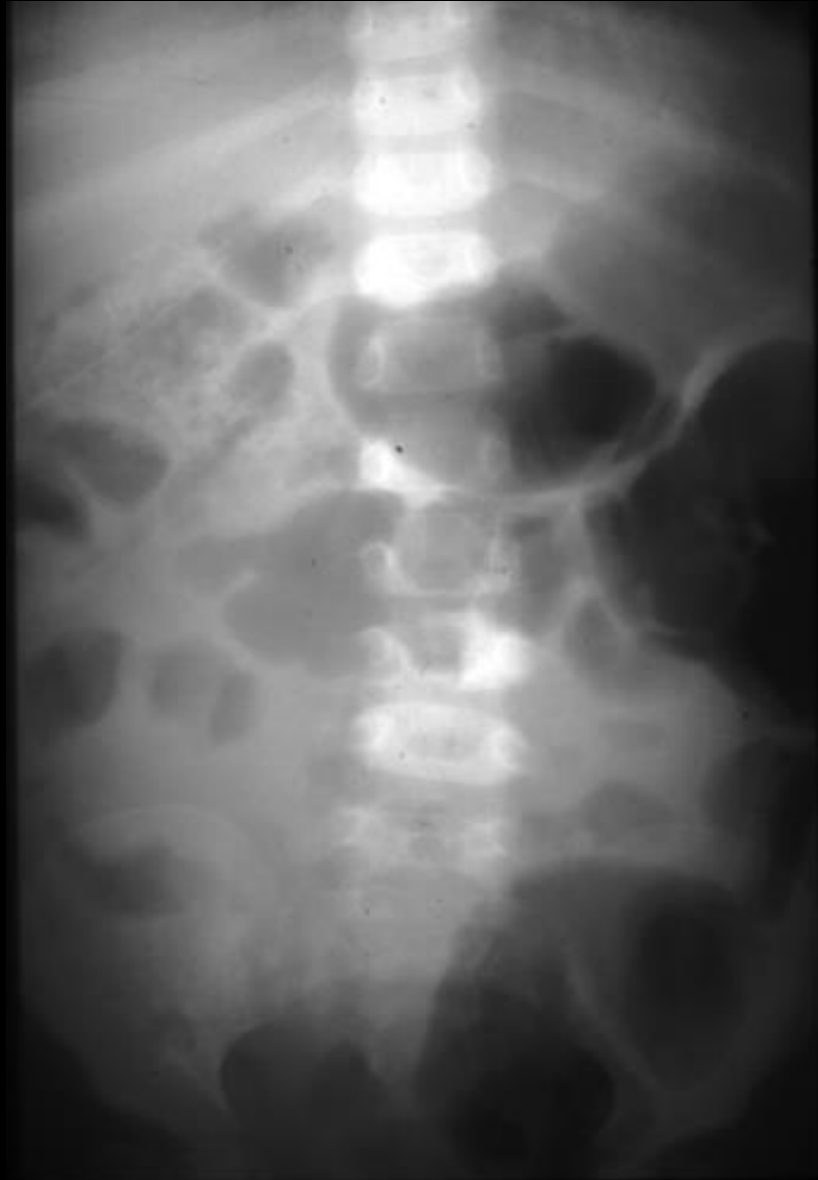
?? Discitis / Osteomyelitis



Lung Ca screening CT

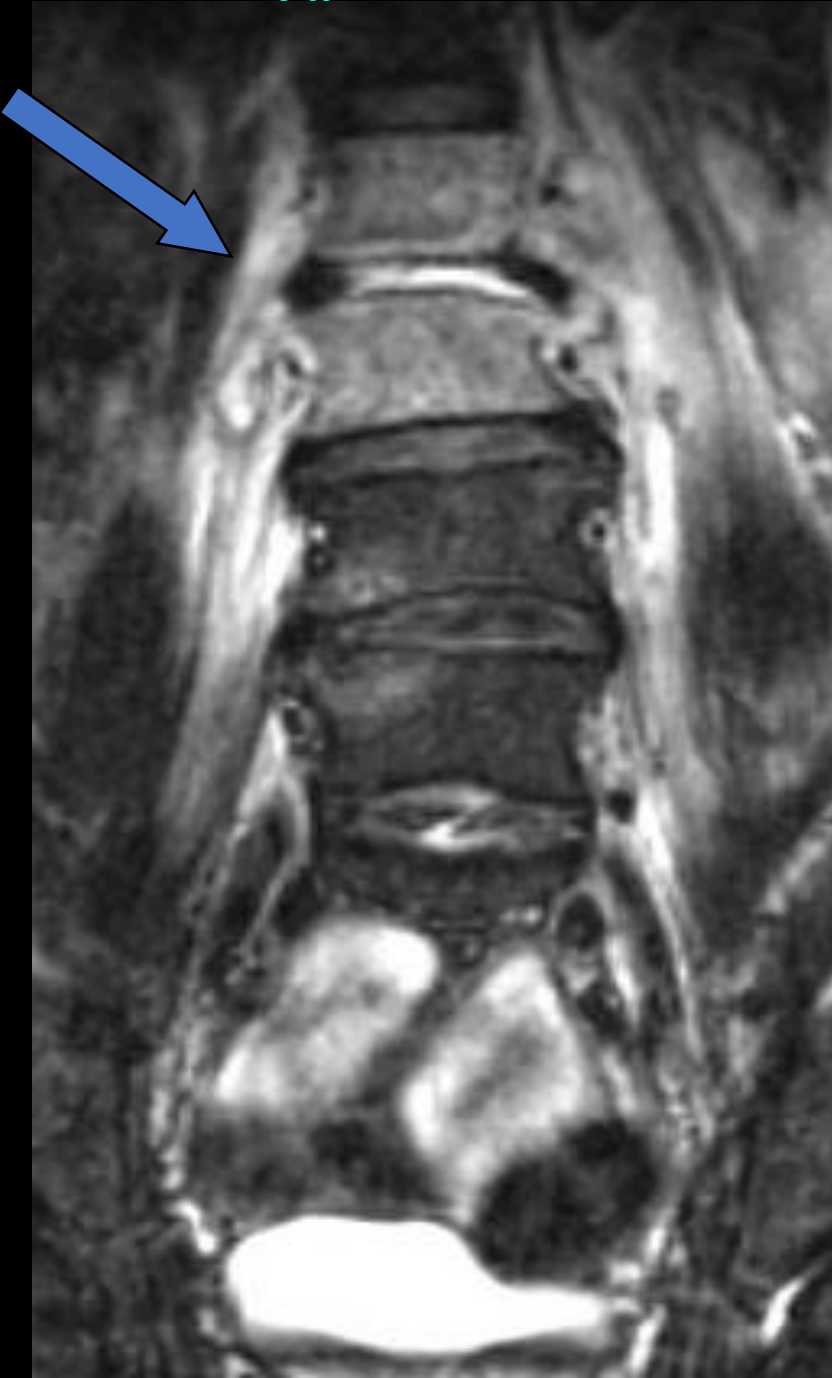
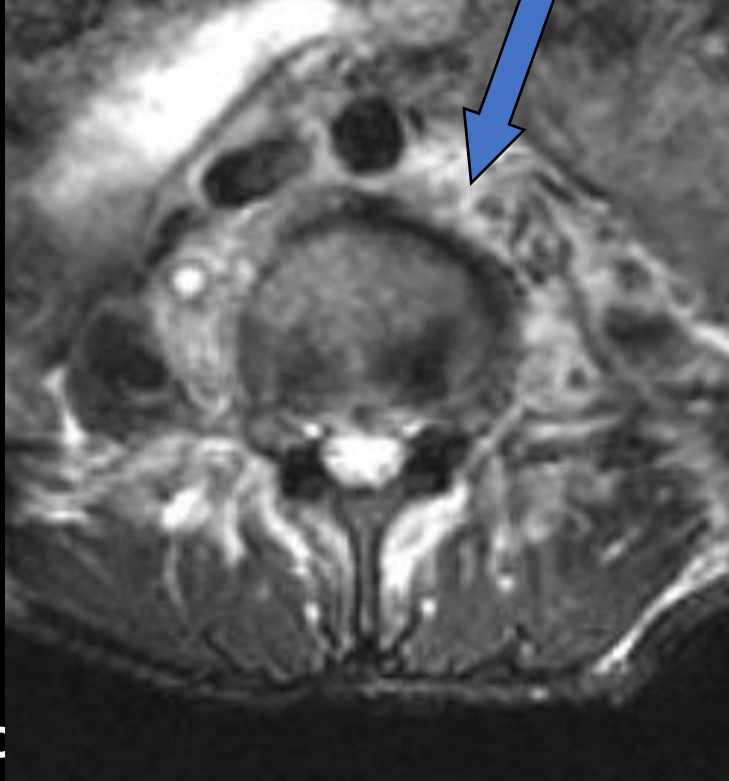
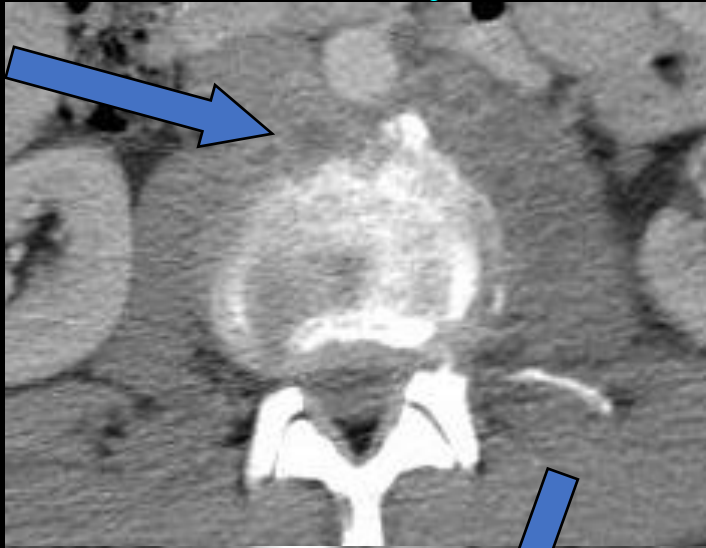


Psoas Abscess / Infectious Spondylitis



Musculoskeletal Infection

www.jefferson.edu/msk



MRI for Infectious Spondylitis

- **Primary method for diagnosis**
- high sensitivity / specificity (90-100 / 80-90%)
- Criteria:
 - *Disc: low T1, high T2 (does not necessarily approximate fluid), + enhancement, rim pattern*
 - *Endplates: low T1, high T2, +enhancement; usu both endplates, can diffusely involve vert body*
 - *Also: soft tissue mass effect, incr. T2, enhancement; endplate irregularity / destruction*

T1



T2



Gd



Discitis Sequelae

- persistent disc narrowing
- kyphosis / scoliosis
- ankylosis
- endplate spurs
- spondylolisthesis
- flexion deformity

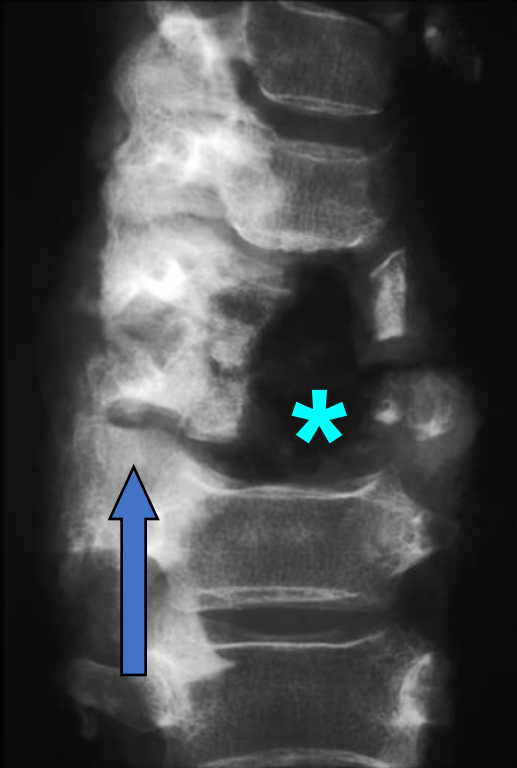


Considerations with atypical organisms

- TB
- Other mycobacteria
- Fungal
- Parasitic

- *multilevel destruction*
- *late preservation of endplates*

TB Spondylitis

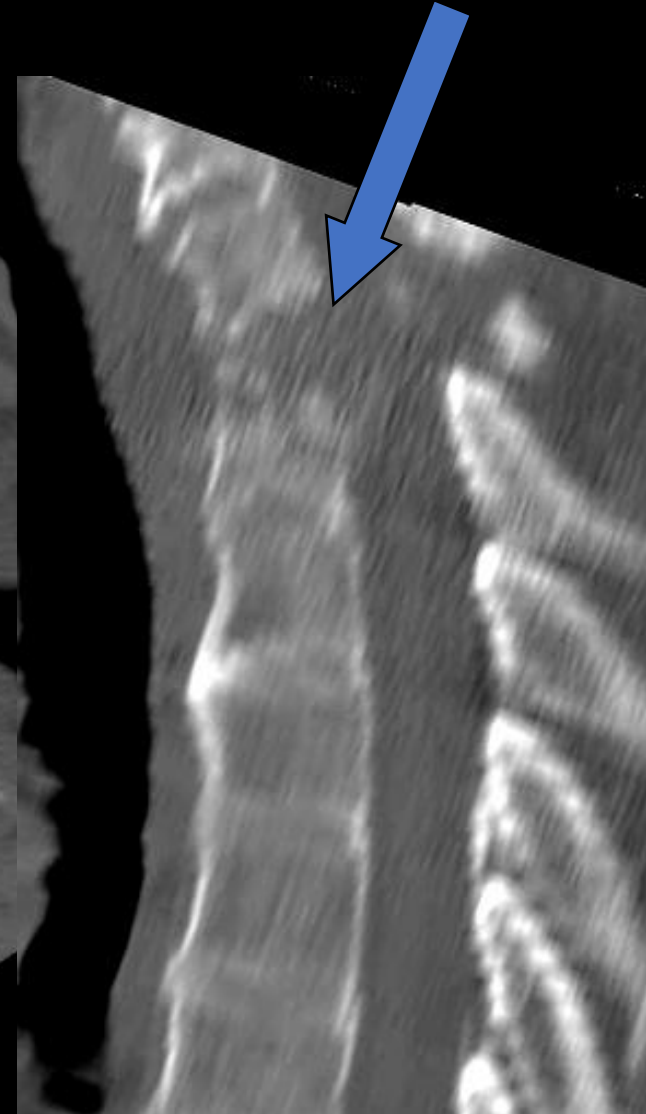
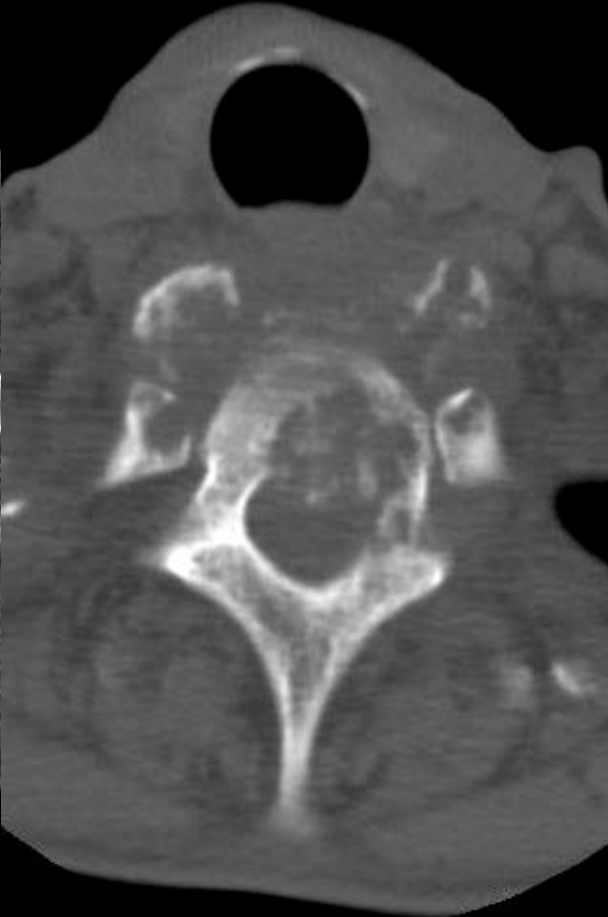


Tuberculosis - Imaging

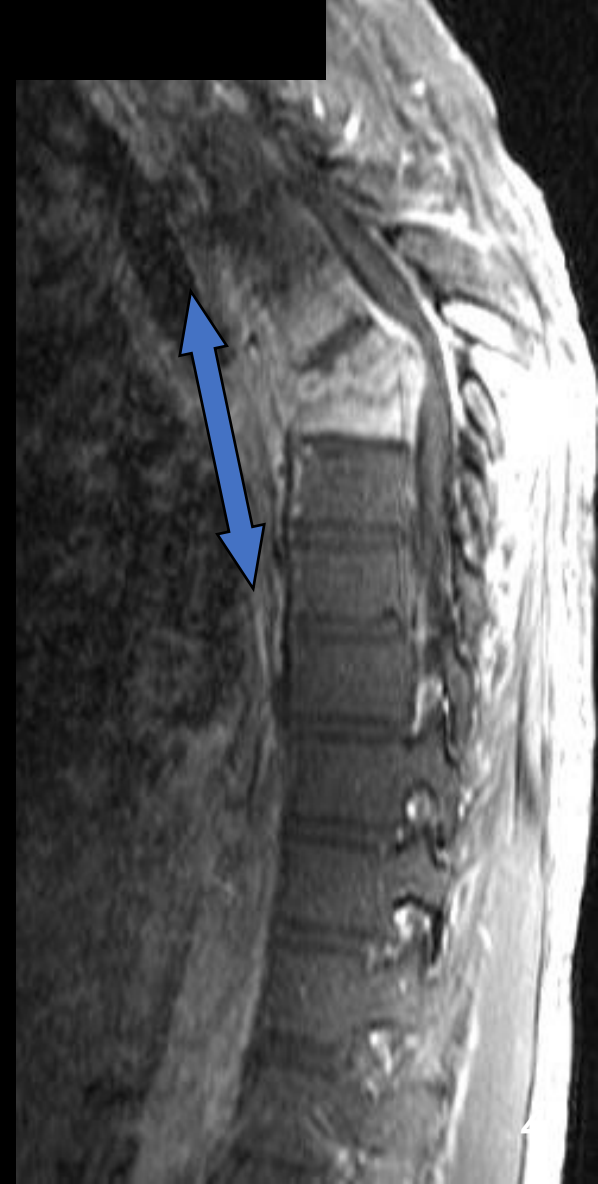
- Classically, preservation of disc height until late
- Paraspinal soft tissue disease - can spread to multiple levels along ligaments
- Late - endplate destruction, sclerosis
- Chronic disease - soft tissue Ca^{++}
- Deformity: kyphosis ('Gibbus'), fusion



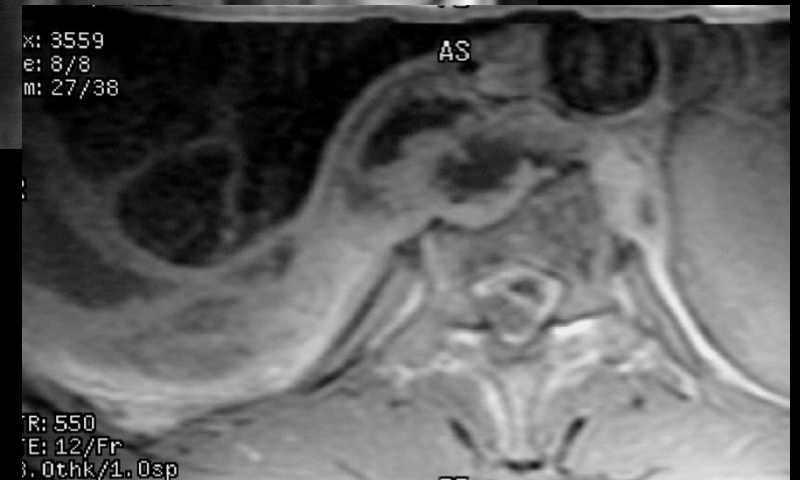
TB Spondylitis



- *Paraspinal spread to multiple levels*
- *Gibbus Deformity*



TB: Subligamentous Spread



Pyogenic

- Rapid progression
- Subligamentous spread less common
- Arterial spread

Tuberculous

- Insidious
- Subligamentous spread common
- Venous spread (Batson's plexus)

Differential Diagnosis

- Degenerative diseases
- Neuropathic disease / instability
- Amyloid (dialysis-associated spondyloarthropathy)
- Iatrogenic (discectomy, failed fusion)
- Fracture / Tumor
- Inflammatory spondyloarthropathies

Type 1 Edematous Degenerative Endplate Change



Degenerative Disc Disease

- Differences from infection
 - Xray/CT - vacuum phenomenon
 - '100% specific' for absence of infection
 - if not present in case of equivocal infection, try lat Xray in extension to elicit vacuum
 - MRI - disc signal / soft tissues
 - disc low signal T1 / T2
 - lack of paraspinal soft tissue mass effect / edema

Flexion / Extension Views



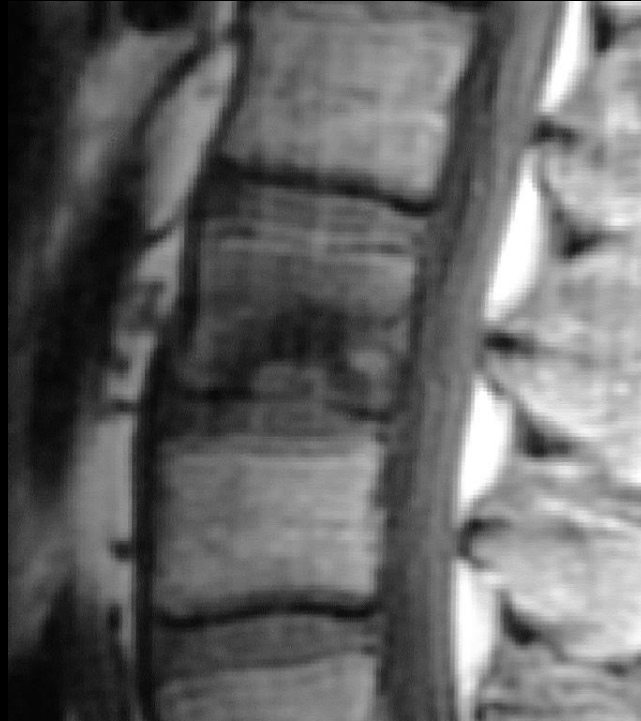
Flexion



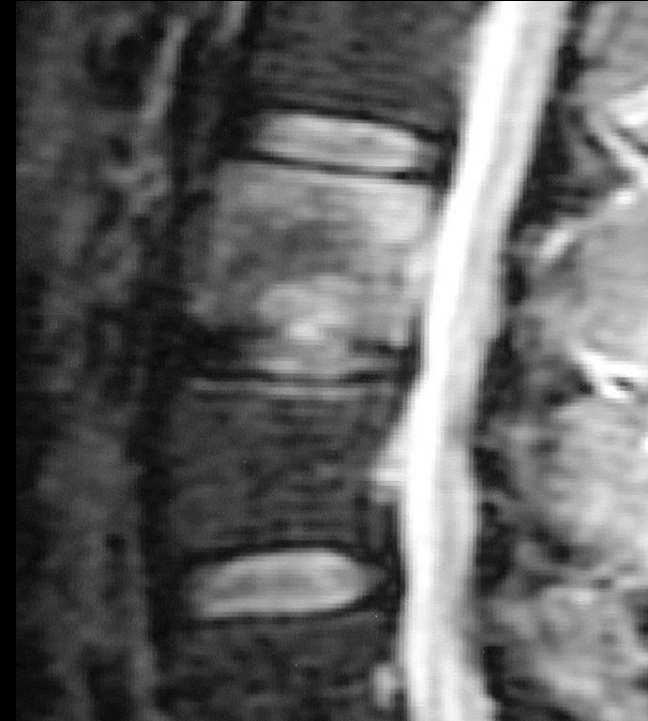
Extension

Acute Schmorl's Node

T1



T2

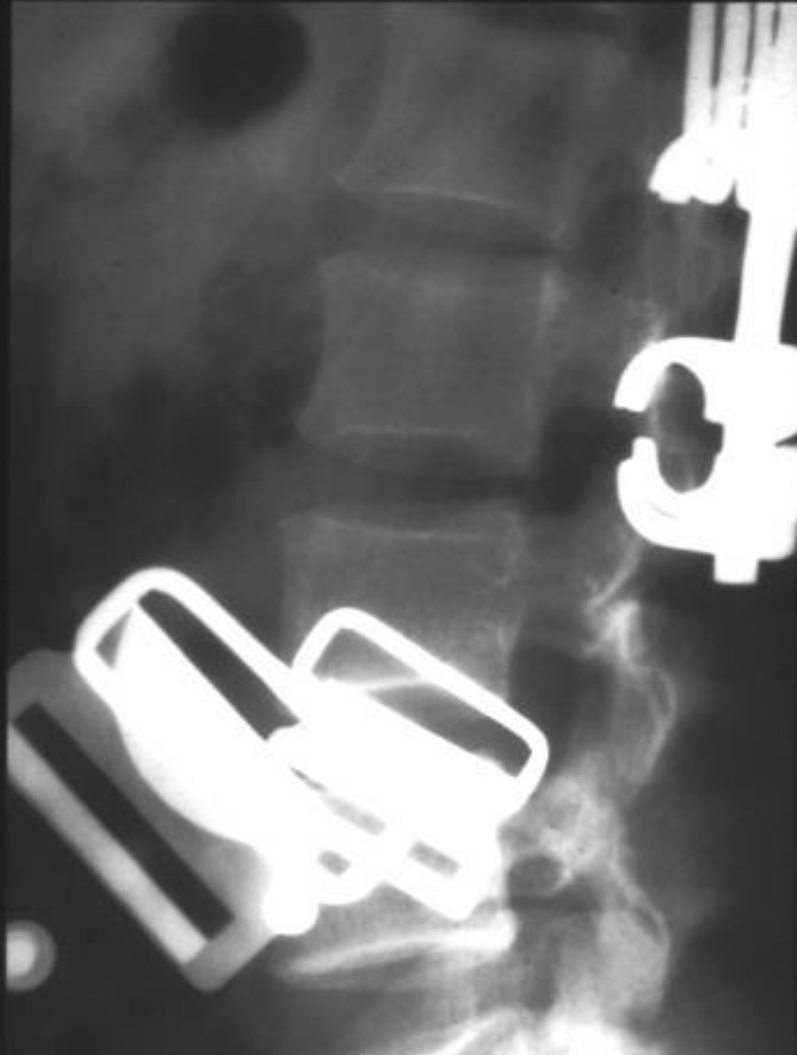


dessication

Neuropathic disease / Segmental instability

- Excess motion +/- decreased sensation
- Imaging similar to infectious discitis ... but:
 - Radiographs
 - disc narrowing
 - endplate irregularity / destruction
 - Osseous productive changes
 - MRI
 - low T1, high T2, +Gd enh in disc / endplates
 - paraspinal edema / mass effect, fluid collections
 - Osseous productive changes

Post-op T-spine fusion



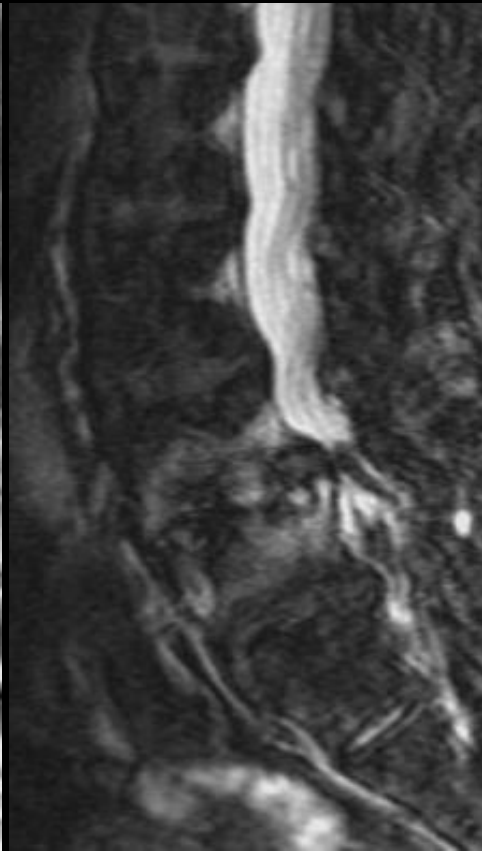
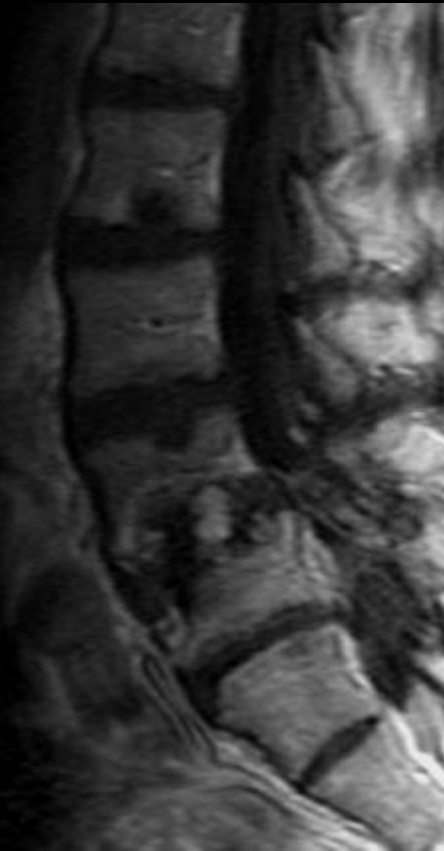
Follow-up – Neuropathic Instability

Neuropathic disease / instability

T1

Gd

STIR



Metabolic Conditions

Amyloid / Dialysis-associated Spondyloarthropathy

- secondary amyloidosis assoc. with CRF, esp dialysis
- Similar to infection:
 - disc narrowing
 - endplate irregularity / destruction / sclerosis at multiple levels
 - soft tissue mass effect / fluid collections

Amyloid of the Spine

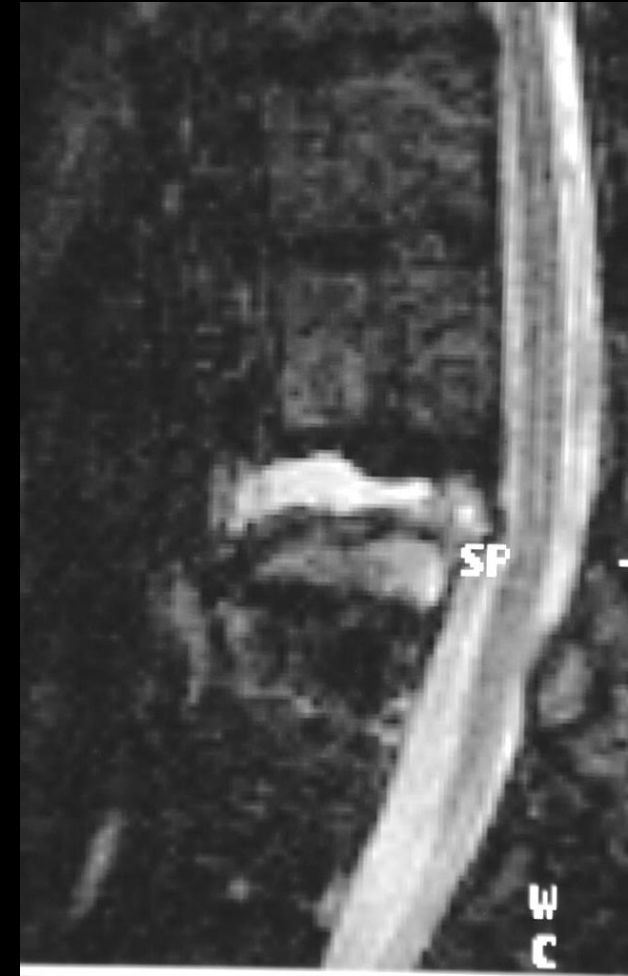
T1



T2



Kummel's Disease



Vacuum cleft may exhibit fluid signal on MRI

Imaging Musculoskeletal Infection

- Imaging essential in prompt diagnosis, esp. radiographs / MRI
- MRI: classic features of disc / endplates, high sensitivity / specificity (fat suppress)
- keep in mind - TB, atypical patterns of fungal / parasitic (tumorlike, degeneration-like)
- Lookalikes: DDD, neuropathic, inflammatory spondyloarthropathies
- When in doubt, 'suck it out' - aspirate and biopsy via US, CT or fluoroscopy



Jefferson





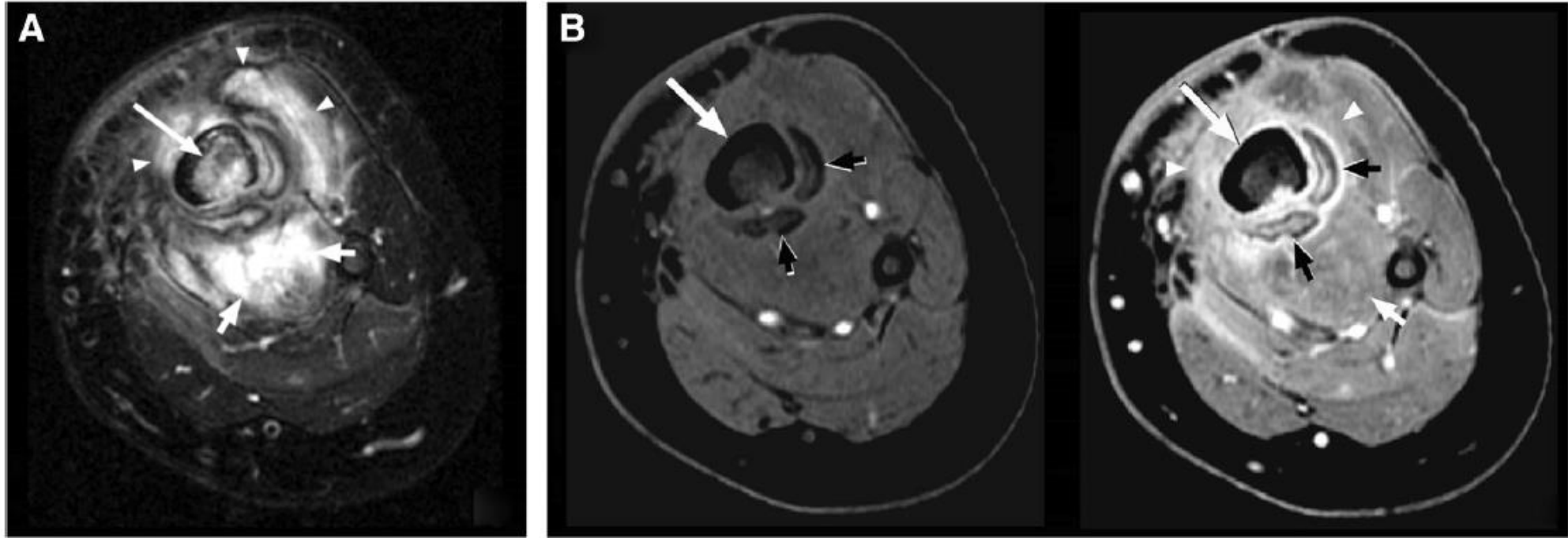


Fig. 6 Involucrum and sequestrum in the lower leg of a 4-year-old male with chronic osteomyelitis. Axial T2-weighted fat-suppressed MR image (**A**) and corresponding axial pre and post-contrast T1-weighted fat suppressed MR images (**B**) of the lower leg show diffuse edema within the tibia (long arrow) with lack of enhancement,

consistent with sequestrum formation. Surrounding muscular edema and enhancement (arrowheads, short white arrows) represents myositis, without discrete soft tissue abscess. The shell of enhancing bone (short black arrows) represents the new bone formation (involucrum)