



Bone Marrow Oedema without Trauma

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Past President, British Society of Emergency Radiology
European Society of Emergency Radiology

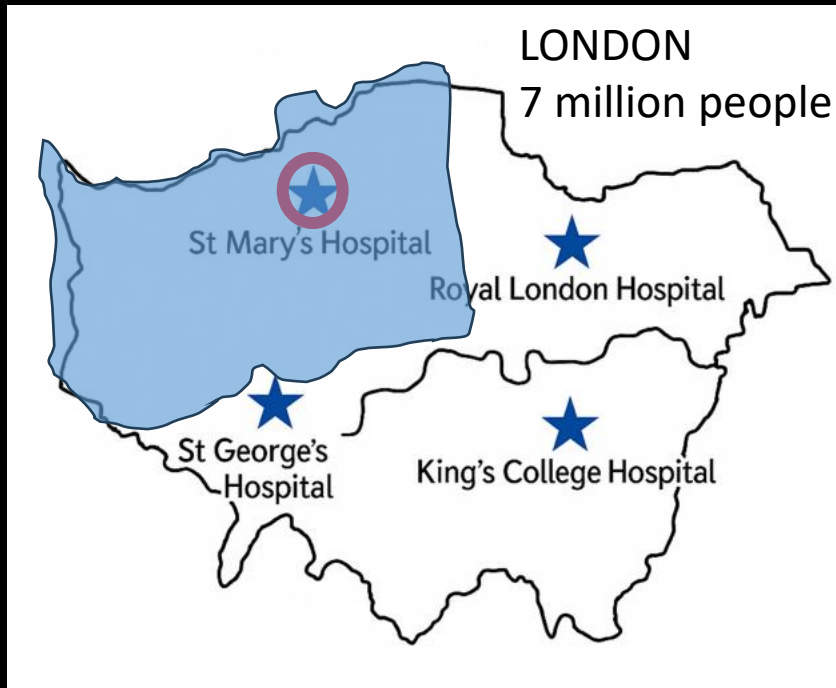


Nordter, Oslo, June 2025





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- Disclosure: Hosted by Everlight Radiology in Sydney October 2024





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Objectives

- Build on learning from this week: QUIZ!!!
- Understand histopathology of bone marrow oedema
- Develop a personal checklist for causes of bone marrow oedema

ALL IMAGING HAS BEEN
ANONYMISED &
PSEUDOANONYMISED

Bone Marrow Oedema (BMO)

What is BMO?

High signal T2 on MRI

low signal T1

intense enhancement post gad

High ADC [T2 shine through] compared to tumour
which is low ADC

A blue square containing the white text "MRI".

MRI

Bone Marrow Oedema (BMO)

What is BMO?

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MRI

Variable Contents:

eosinophilic extracellular fluid in bone marrow

swollen fat cells

AND/OR medullary necrosis

AND/OR blood products

AND/OR inflammation

AND/OR fresh granulation tissue (eg post operative)

HISTOLOGY

Bone Marrow Oedema (BMO)

What is BMO?

High signal T2 on MRI

low signal T1

intense enhancement post gad

High ADC [T2 shine through] compared to tumour
which is low ADC

MRI

Learning point

Bone Marrow Oedema is not a
single histopathological process

Variable Contents:

eosinophilic extracellular fluid in bone marrow

swollen fat cells

AND/OR medullary necrosis

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AND/OR inflammation

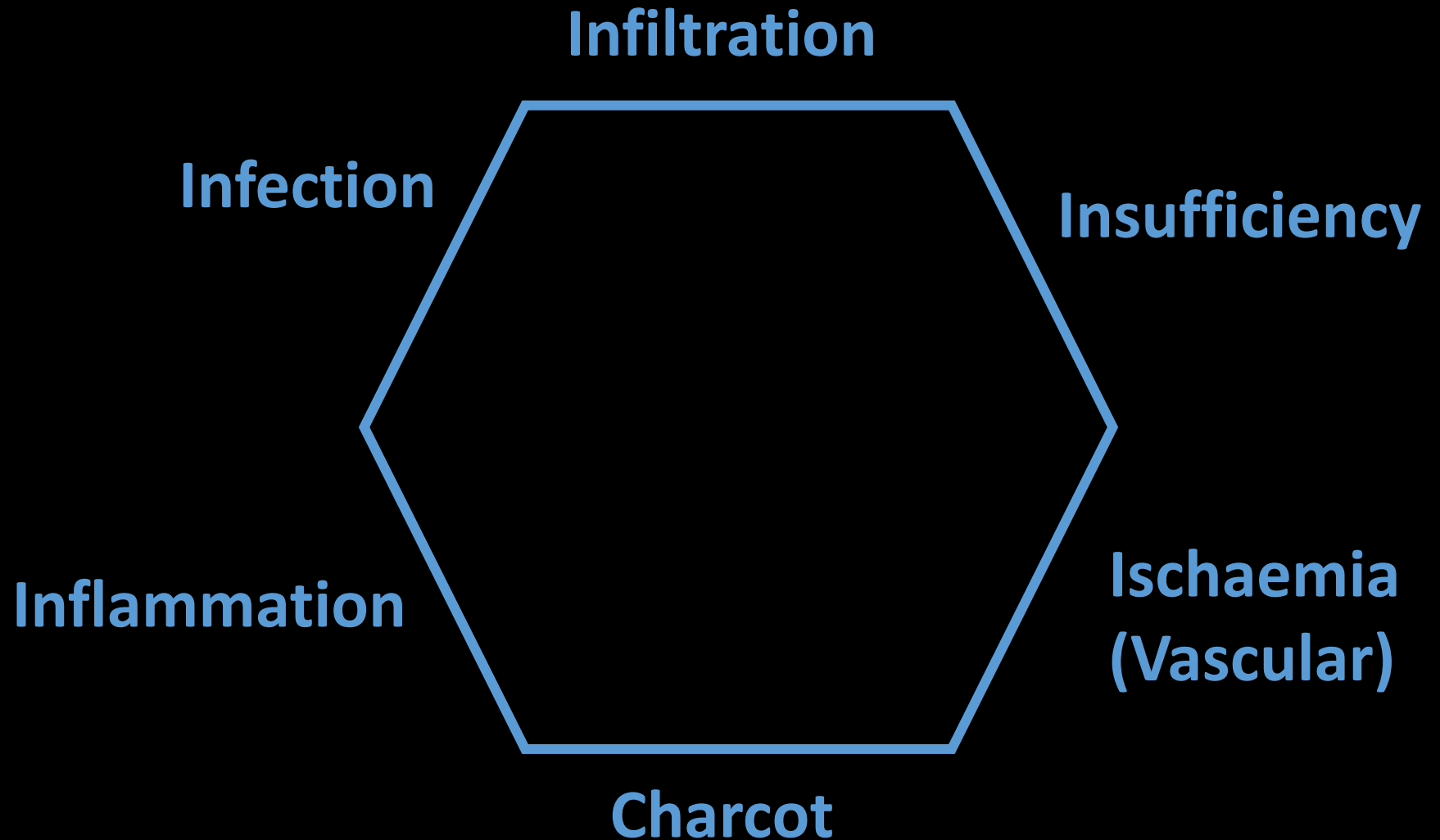
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HISTOLOGY



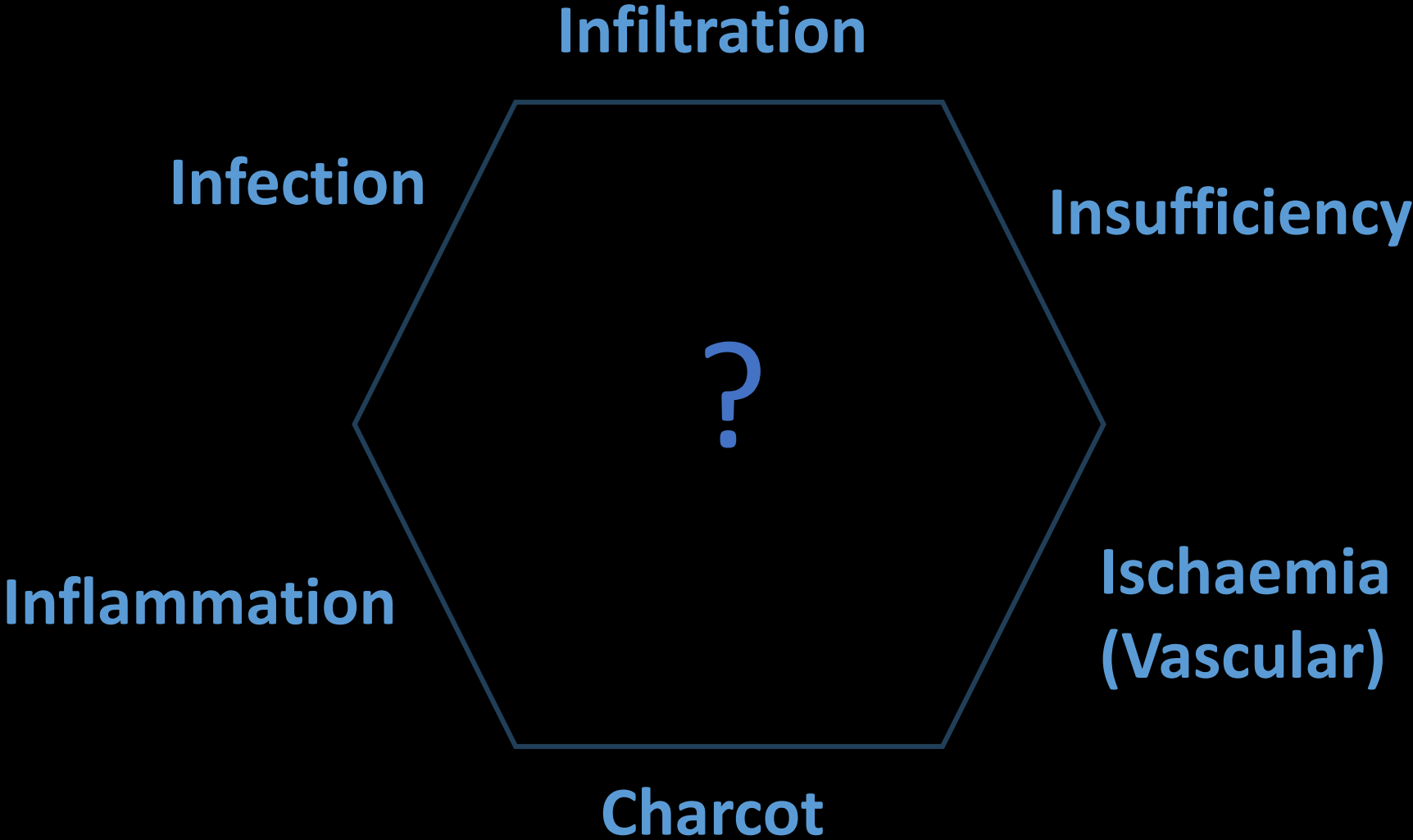
CHECKLIST :Causes of Bone Marrow Oedema

5 x I
1 x C

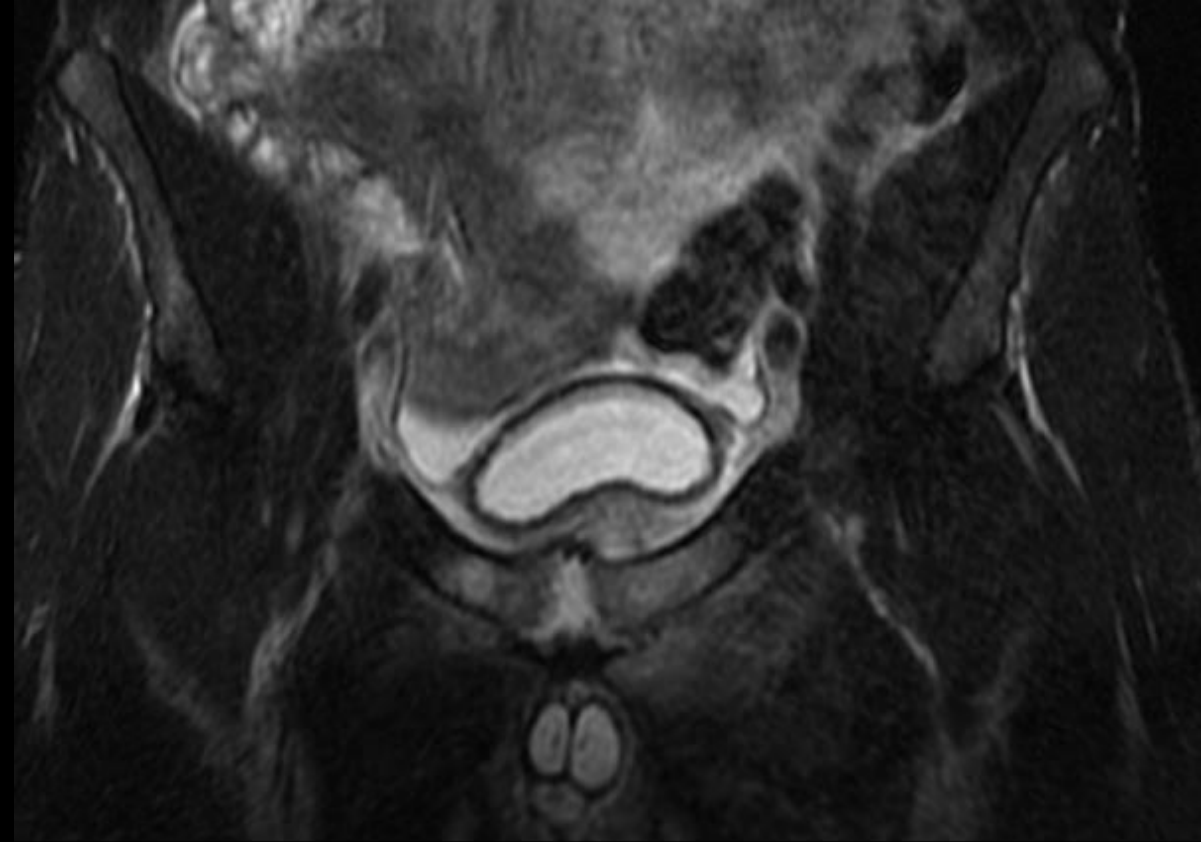
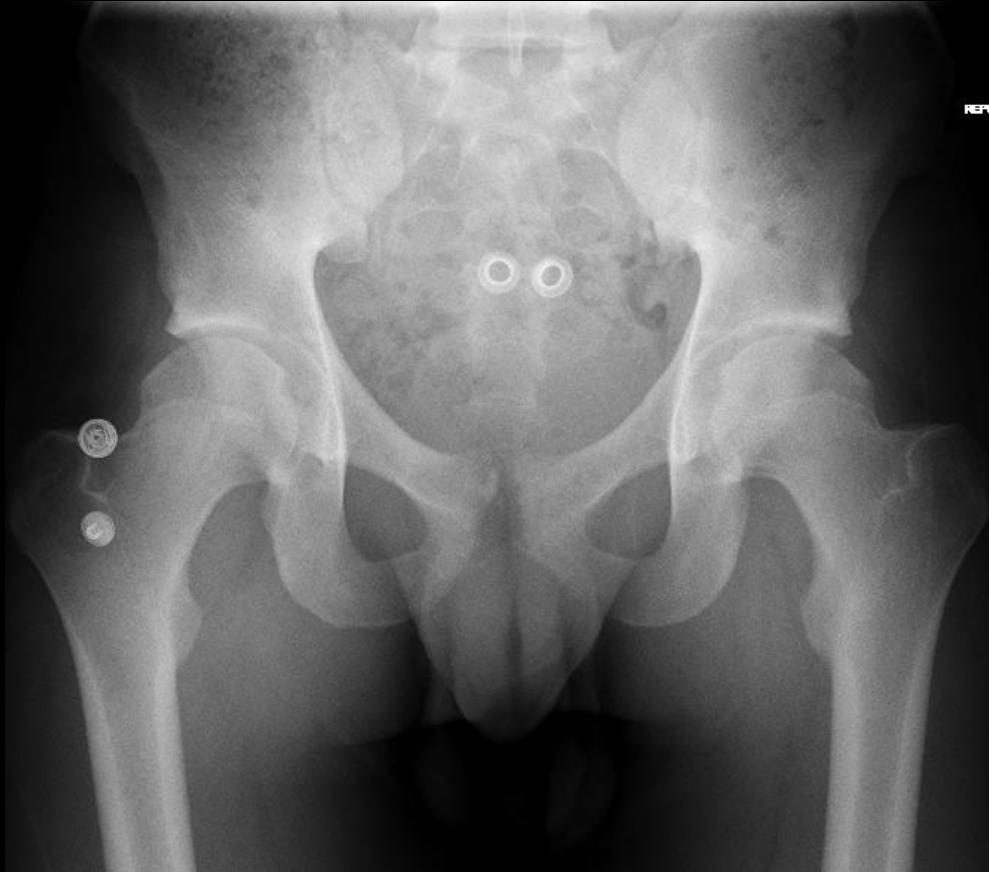




Causes of Bone Marrow Oedema (BMO)



Case 1: Post prostatectomy



What is the diagnosis- choose one

Inflammation

0%

Infection

0%

Ischaemia

0%

Insufficiency

0%

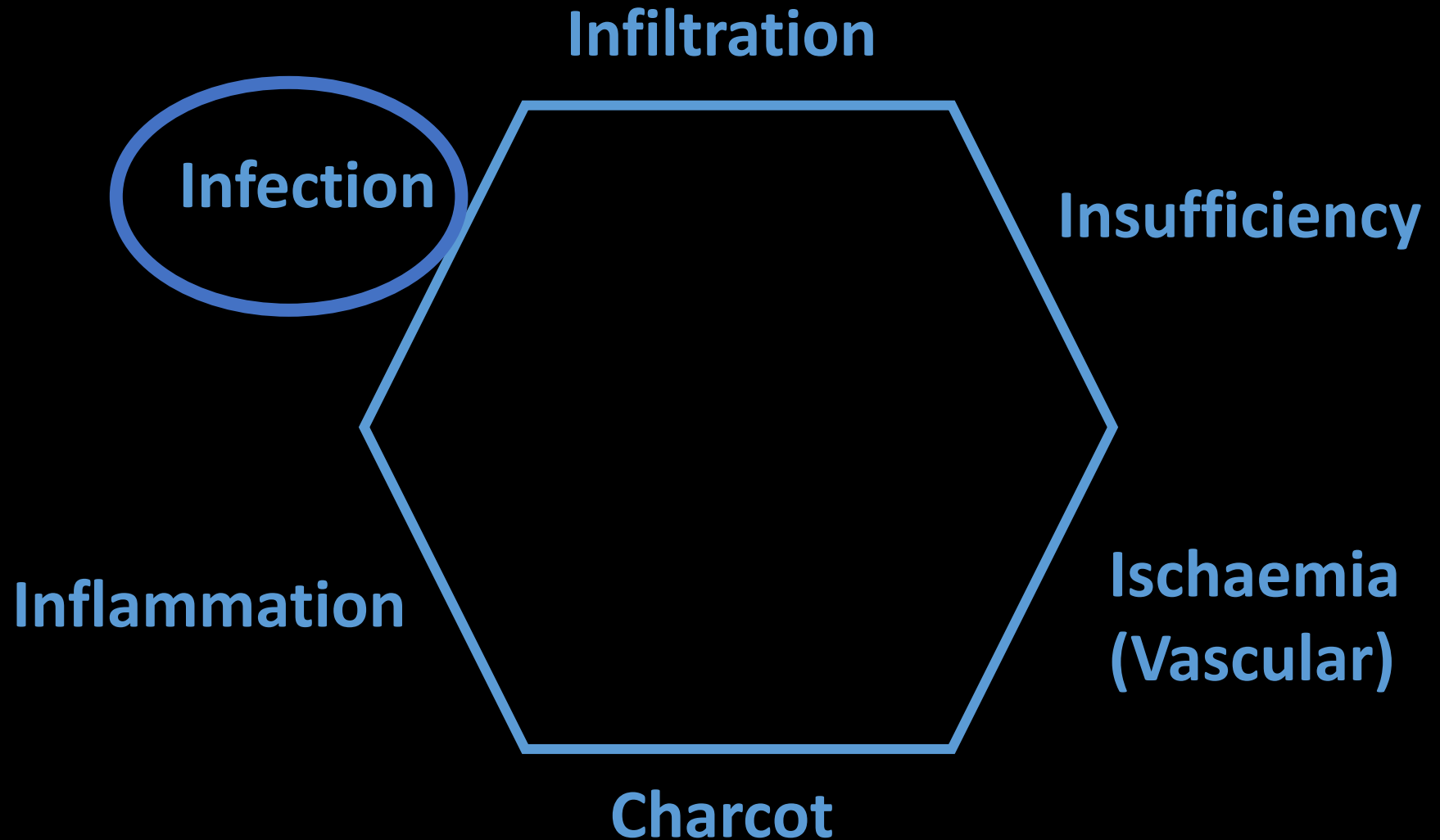
None of the above

0%

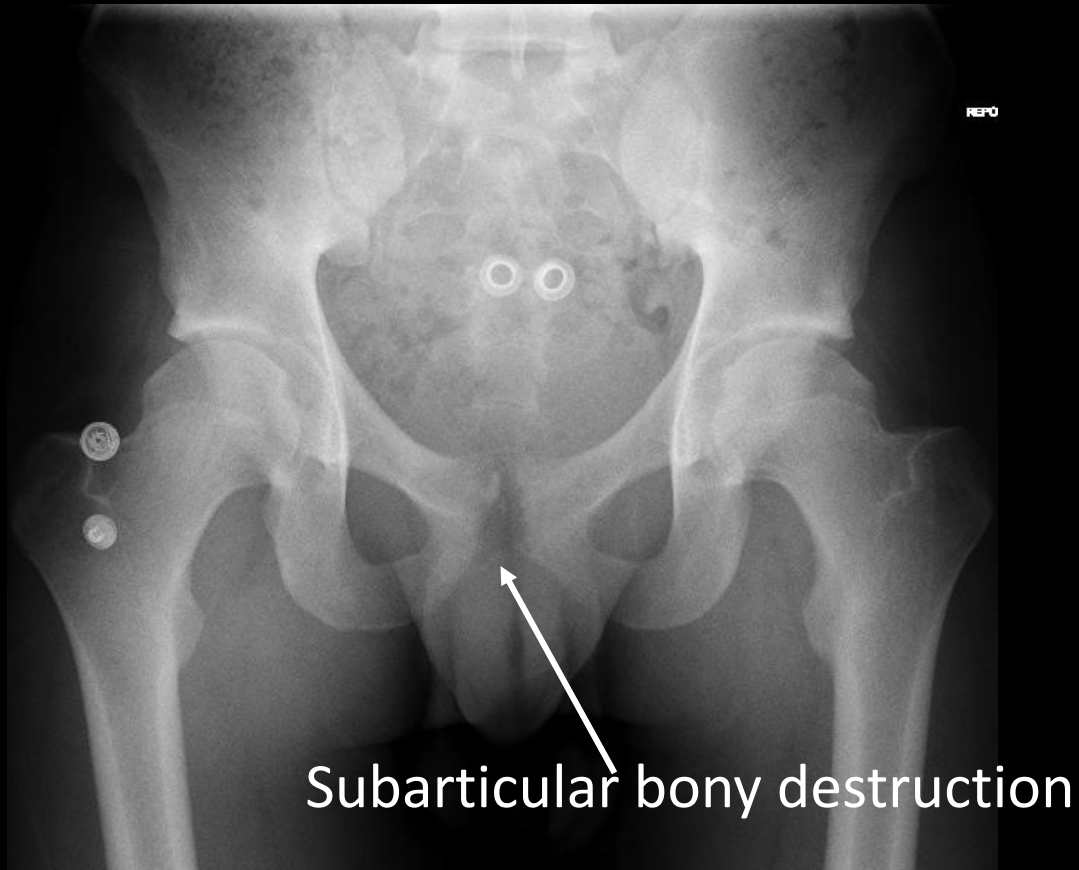
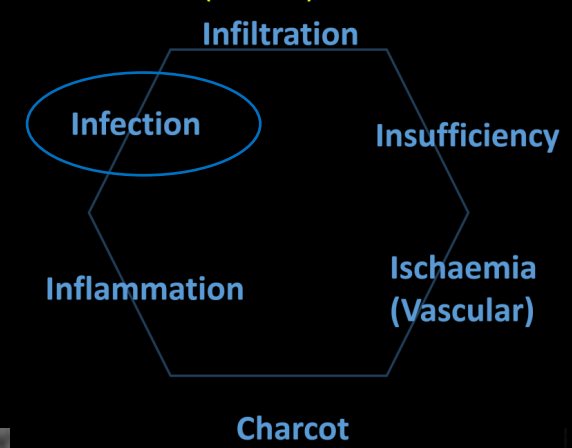


CHECKLIST :Causes of Bone Marrow Oedema

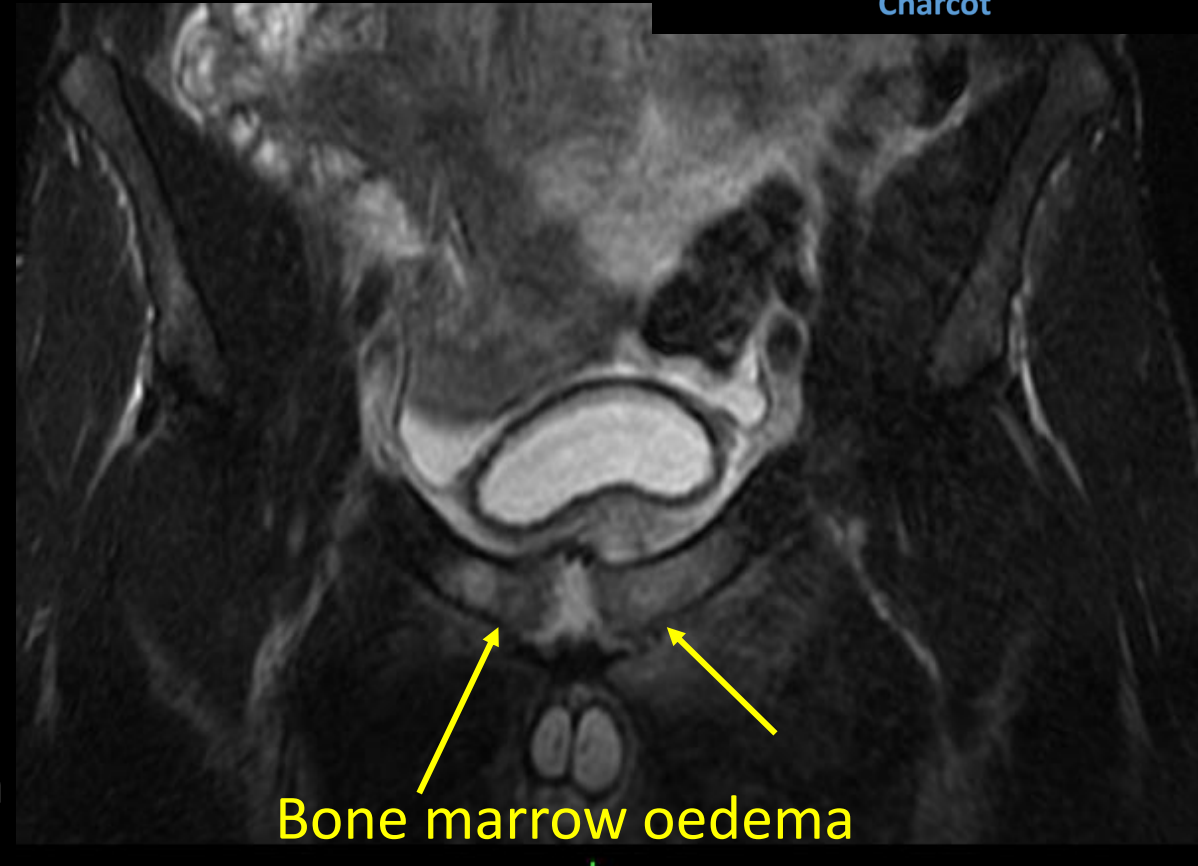
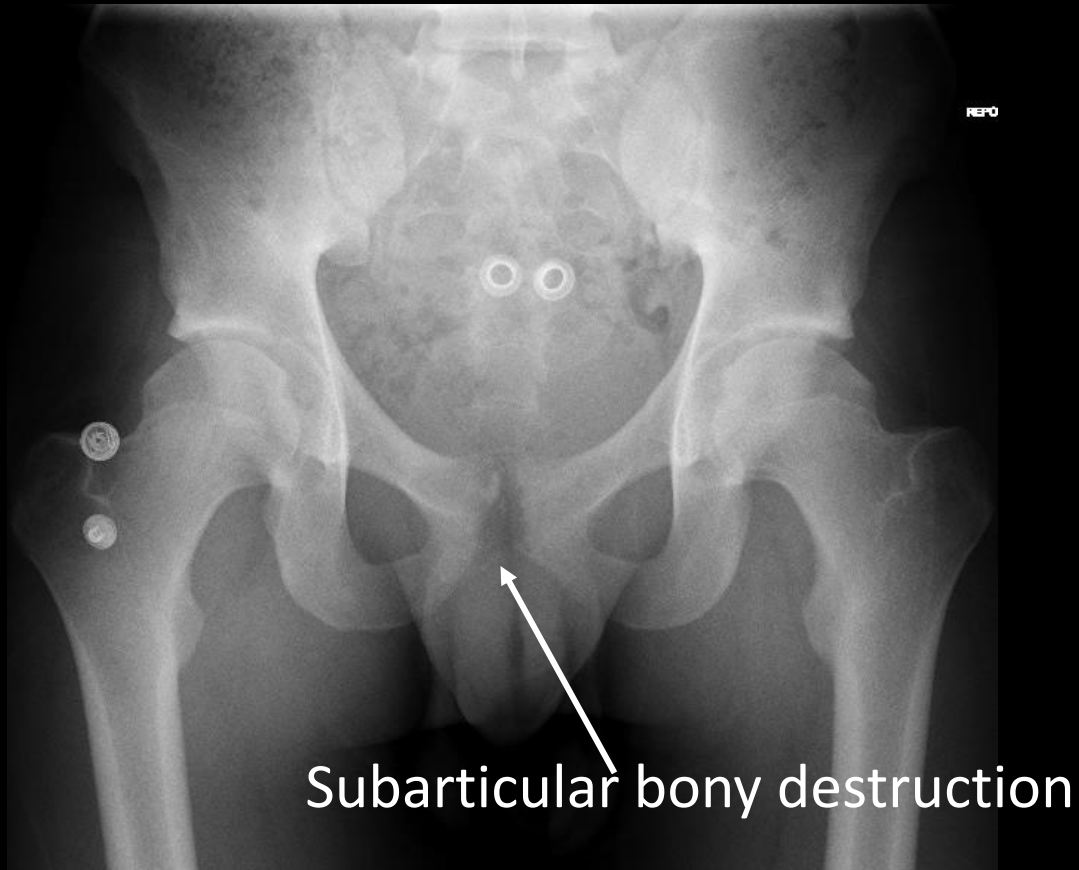
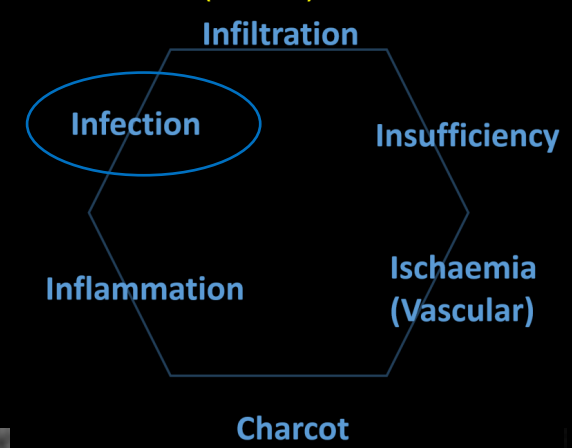
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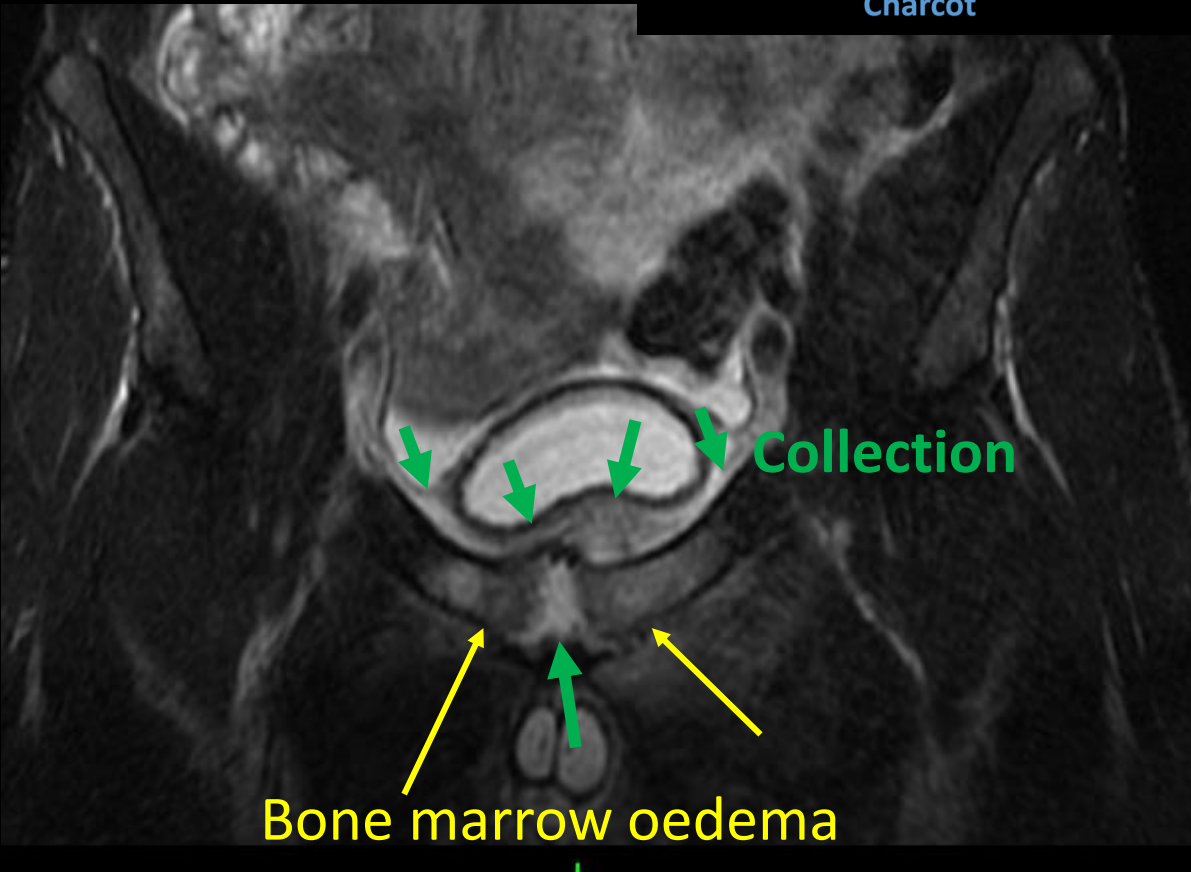
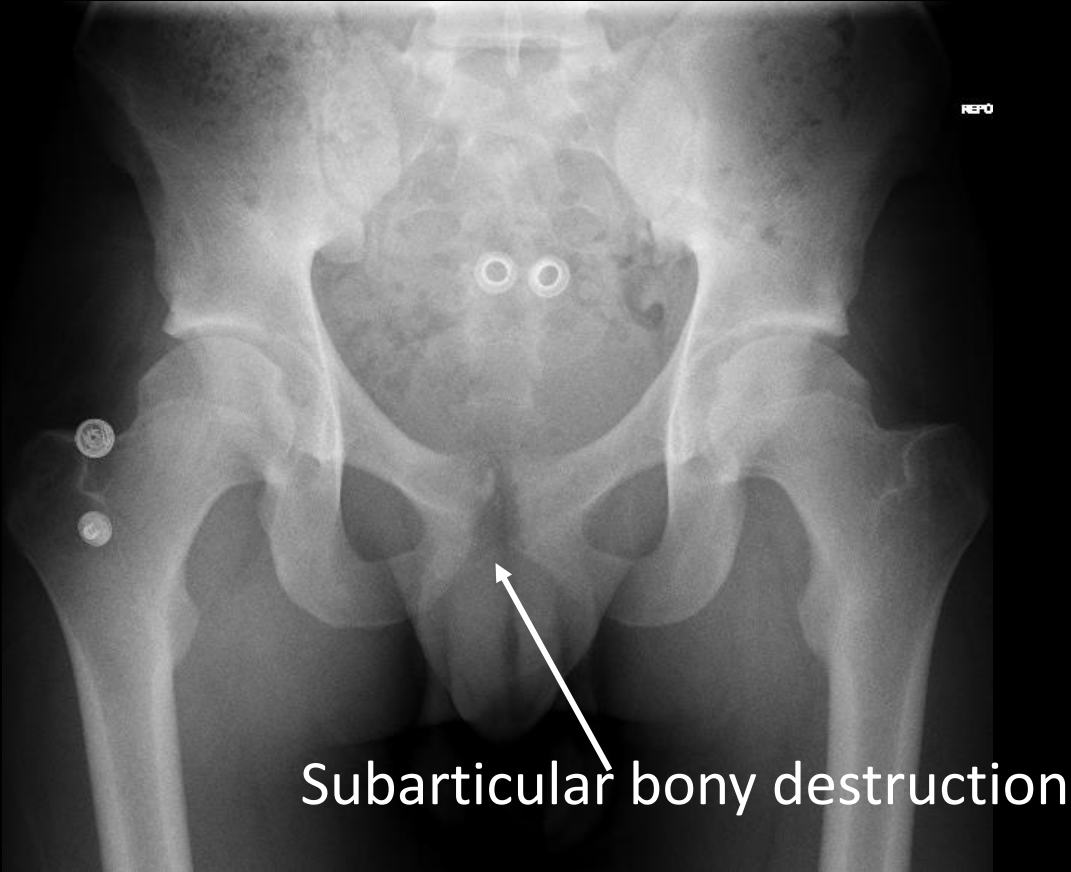
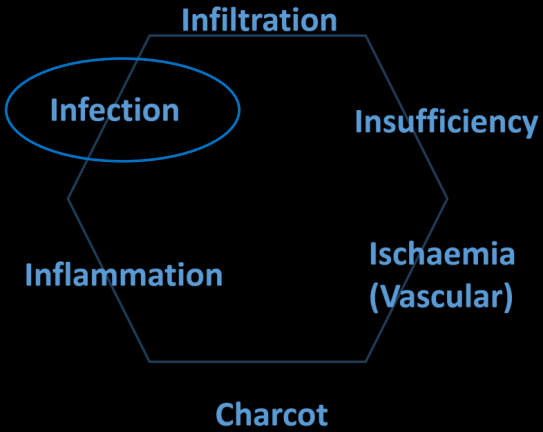
Case 1: Post prostatectomy



Case 1: Post prostatectomy



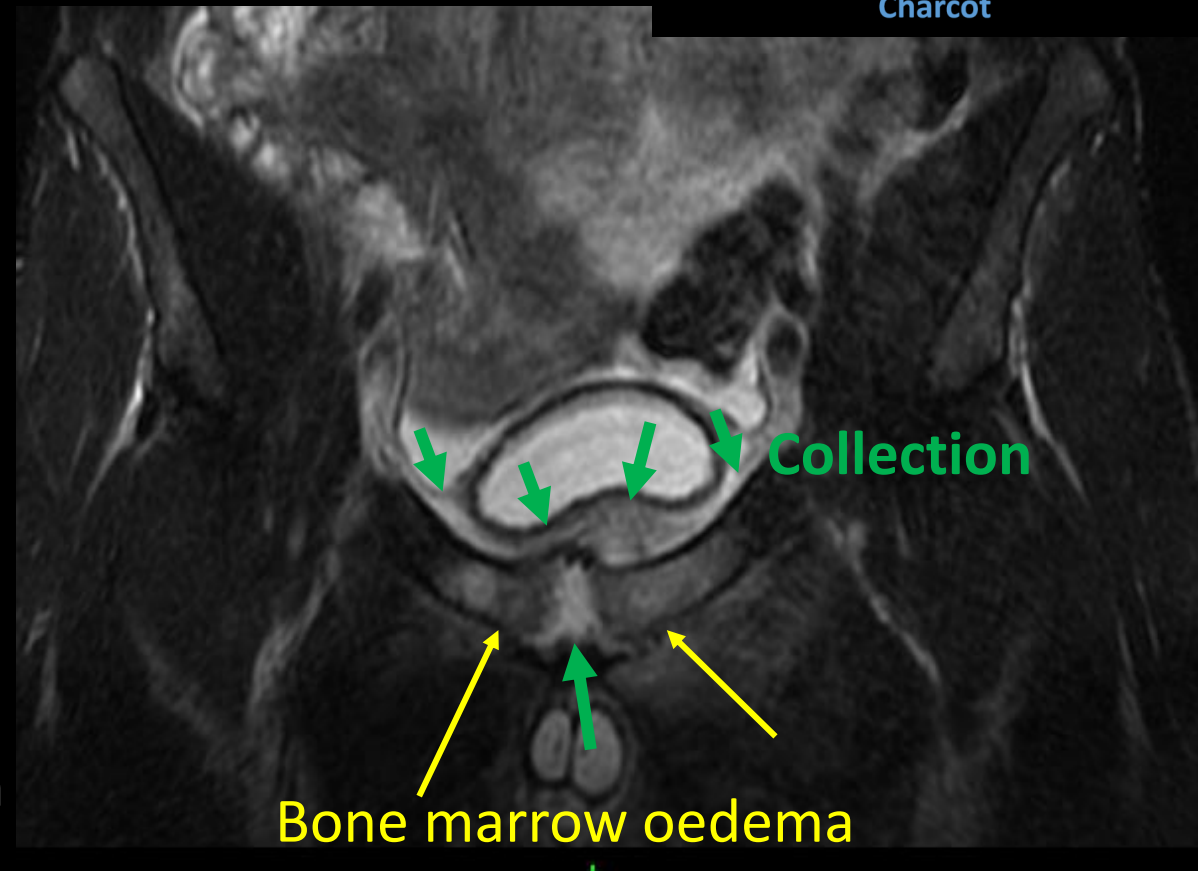
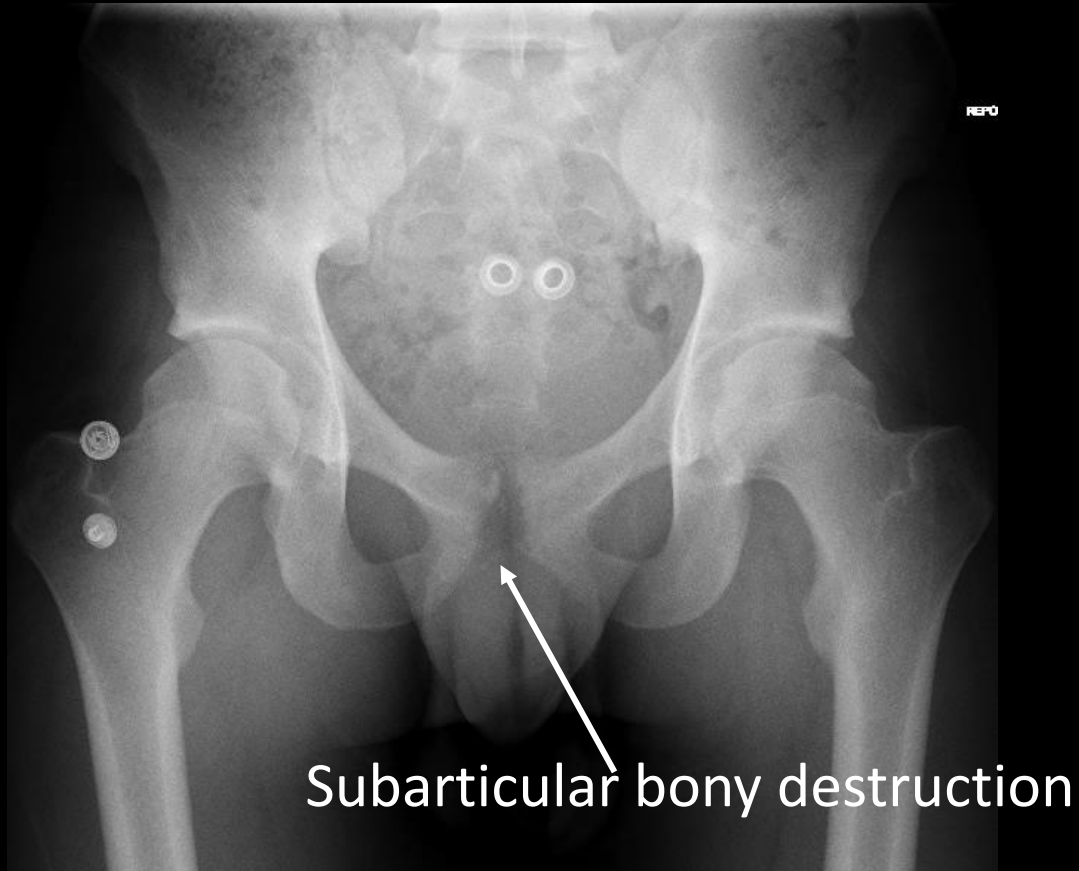
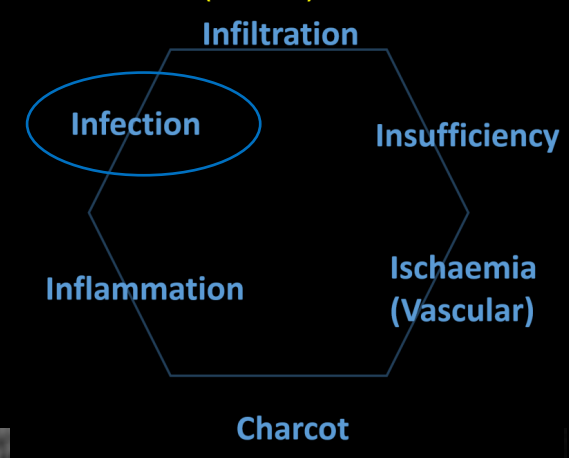
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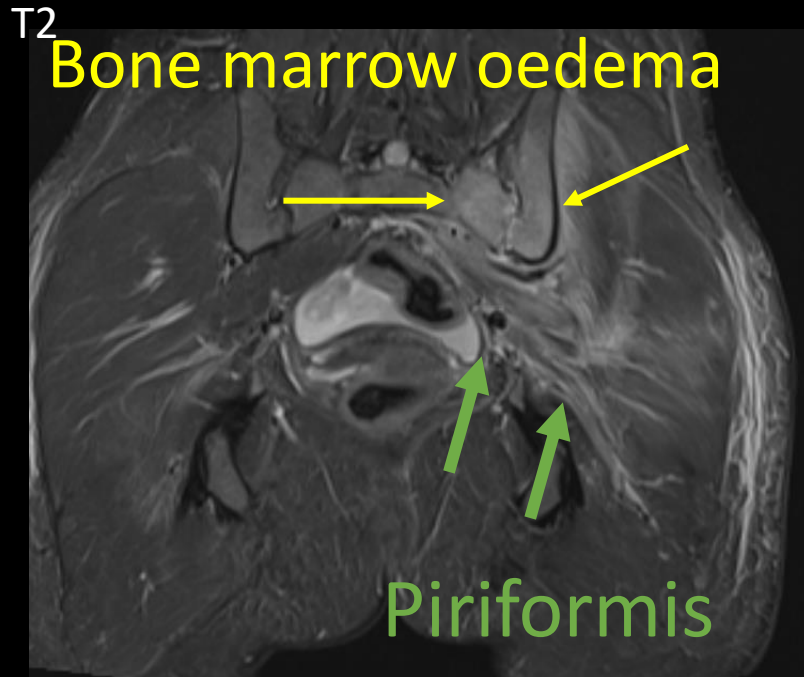
Case 1: Septic Arthritis Pubic symphysis

Learning point

Joint centred? Septic Arthritis needs to be thought of first

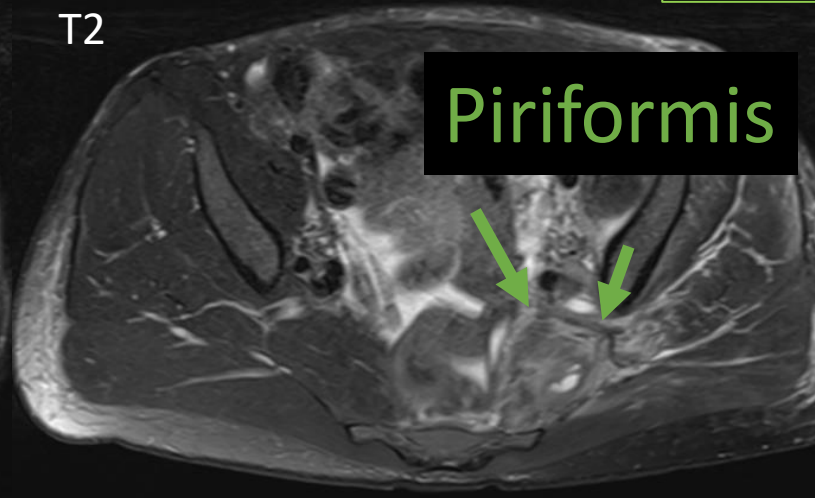
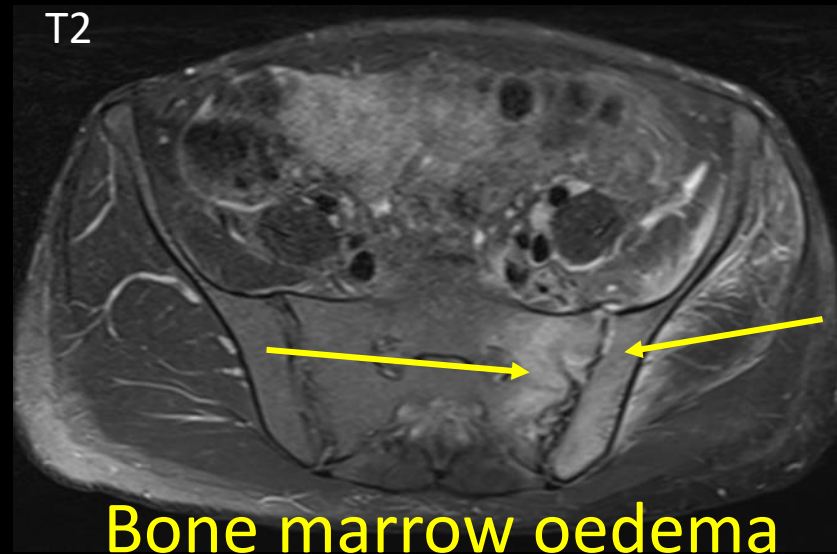


Companion case: LEFT SIJ septic arthritis



Organism:
Staph
Aureus

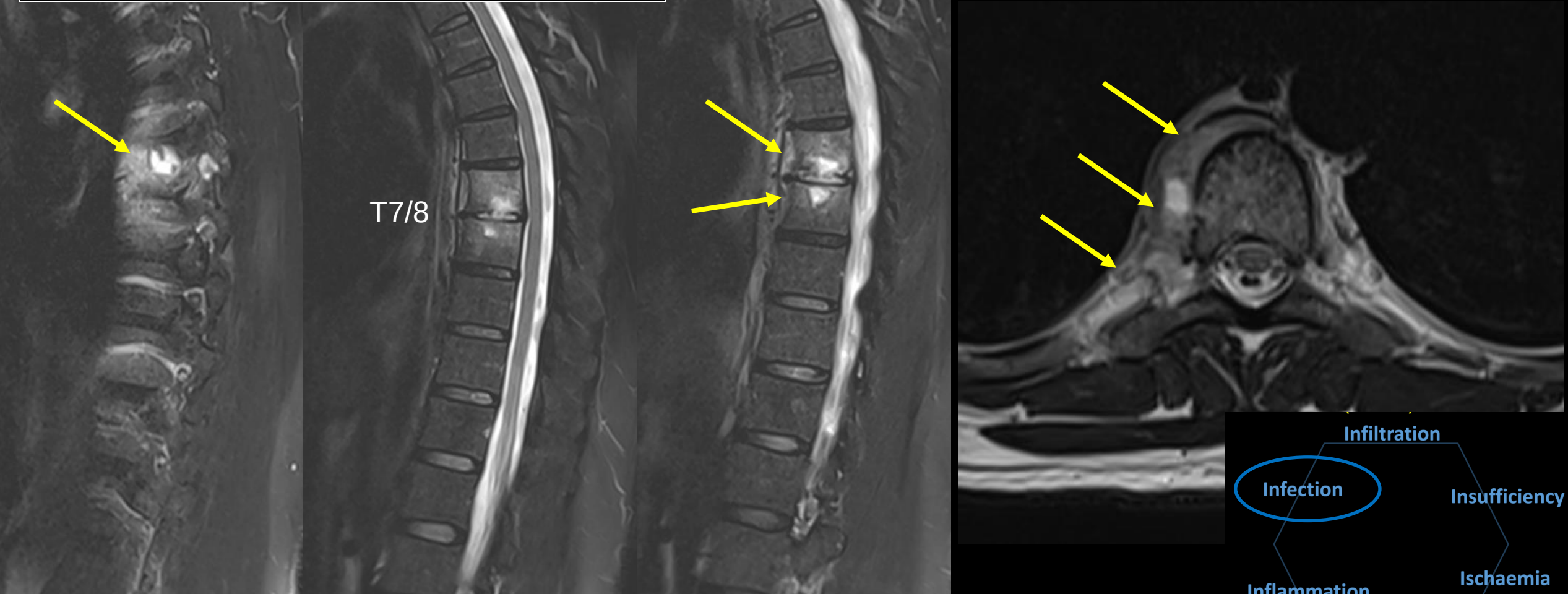
Learning point:
In Unilateral Sacroiliitis
Consider infection first
Check for piriformis involvement



Companion Case: Brucella Diskitis/Septic Arthritis

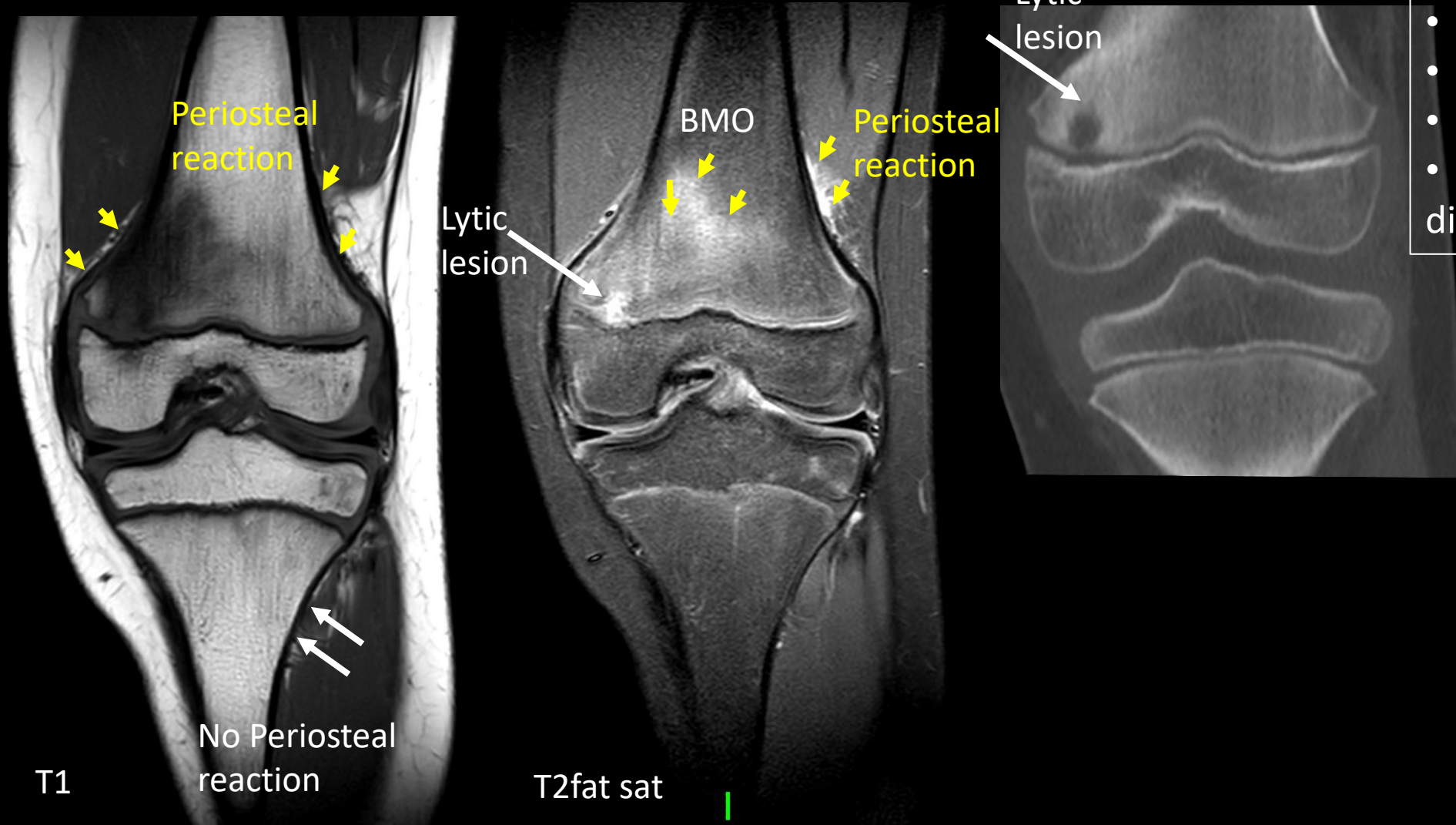
Learning point

Joint centred? Septic Arthritis needs to be excluded first

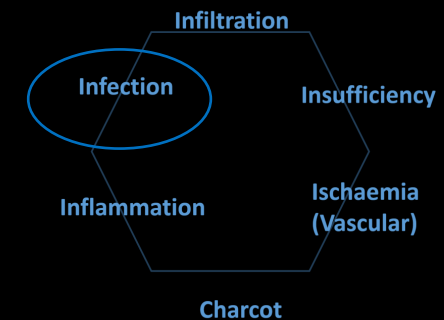


Longstanding backpain. T7/8 disc- centred paraspinal infection

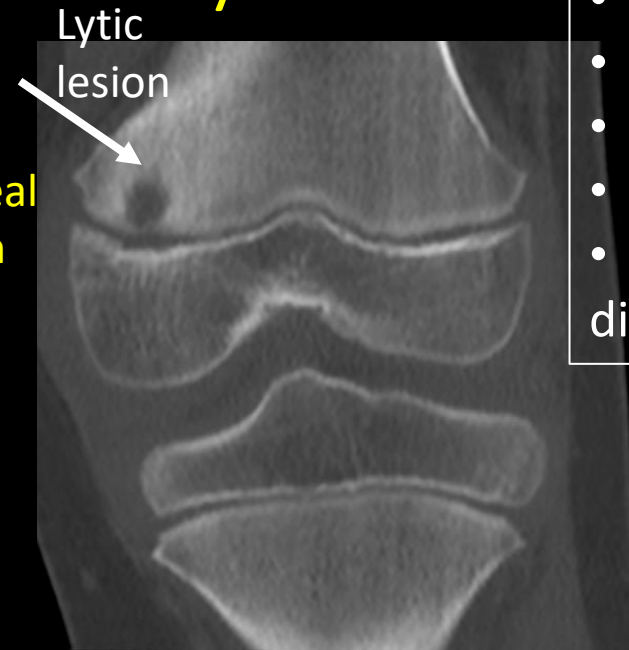
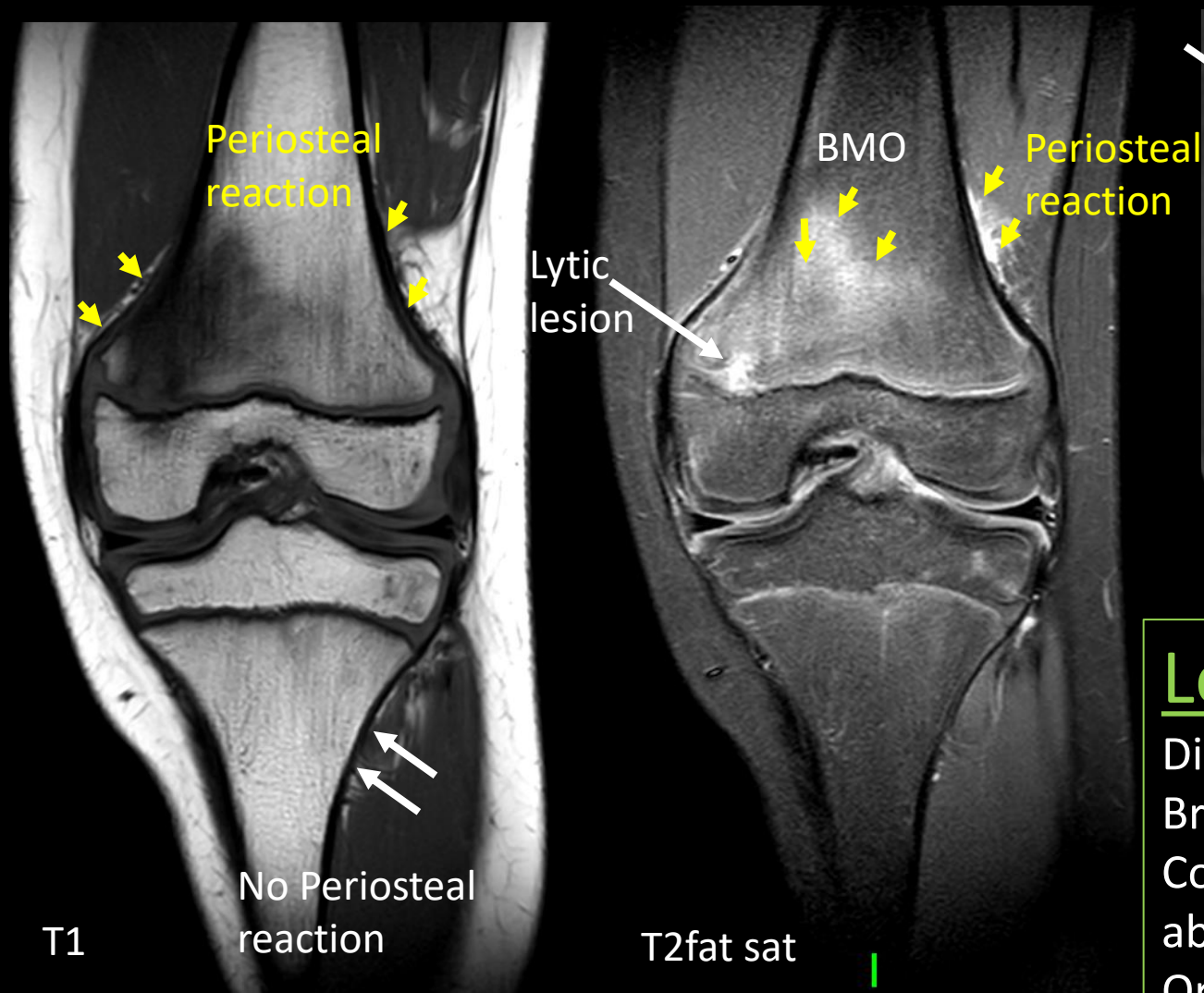
Companion Case: 6 yo. Recent gastroenteritis, leg pain: Brodie's Abscess Subacute Osteomyelitis



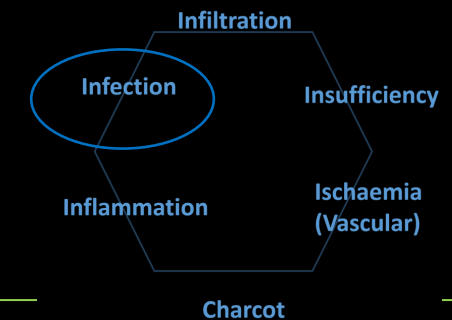
- Metaphyseal
- Communicates w physis
- Surrounding BMO
- Periosteal reaction
- Haematogenous or direct spread



Companion Case: 6 yo. Recent gastroenteritis, leg pain: Brodie's Abscess Subacute Osteomyelitis



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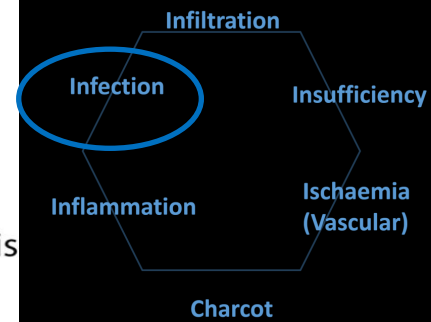
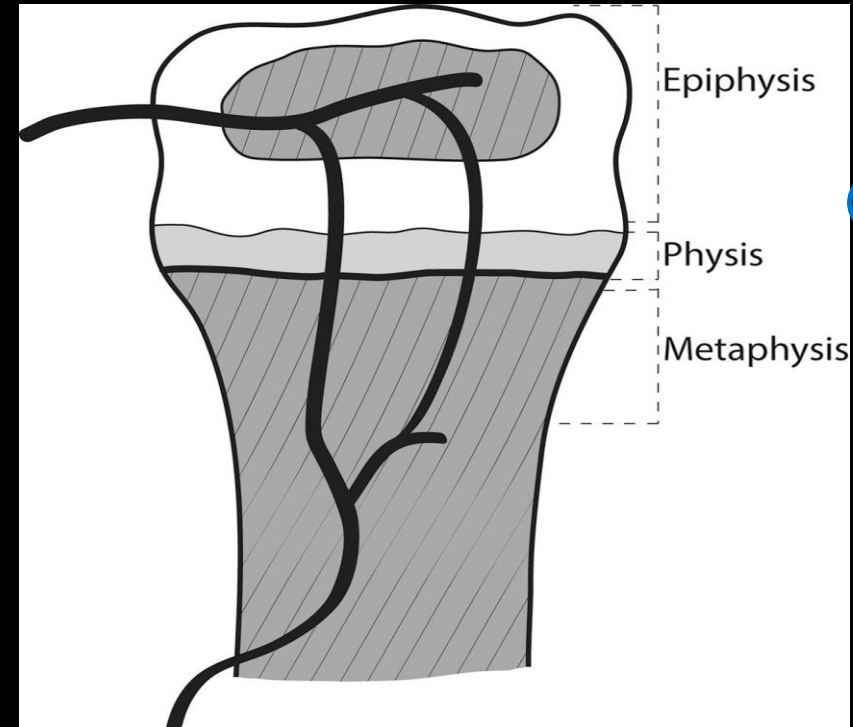
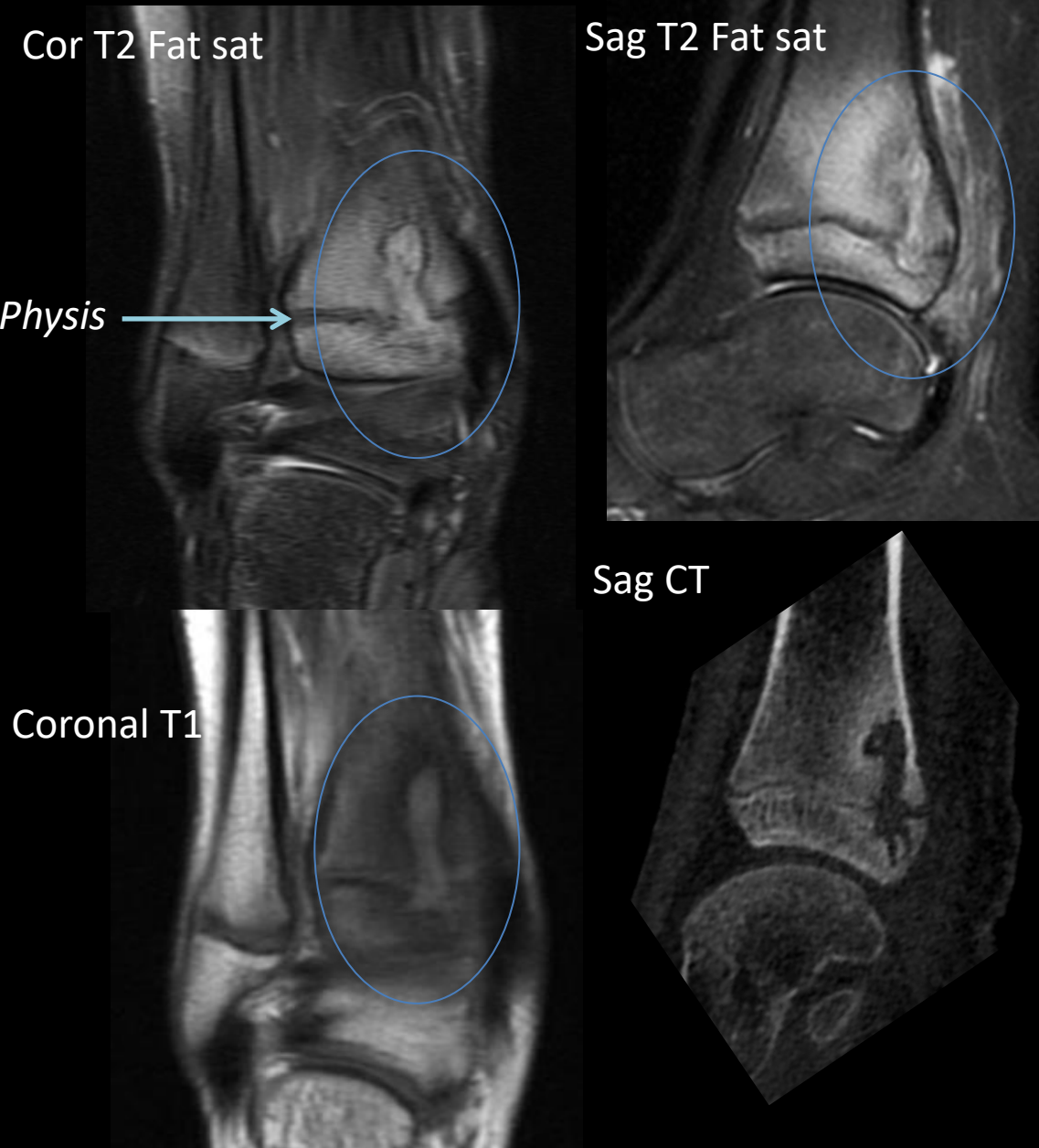
Learning point

Diagnosis often delayed (eg 1-12 months)

Brodie's abscess = subacute osteomyelitis (walled off)
Communication w physis highly suggestive of Brodie's abscess

Organism only found in 50% (staph, strep common)

Companion Case: 16 month old: Osteomyelitis



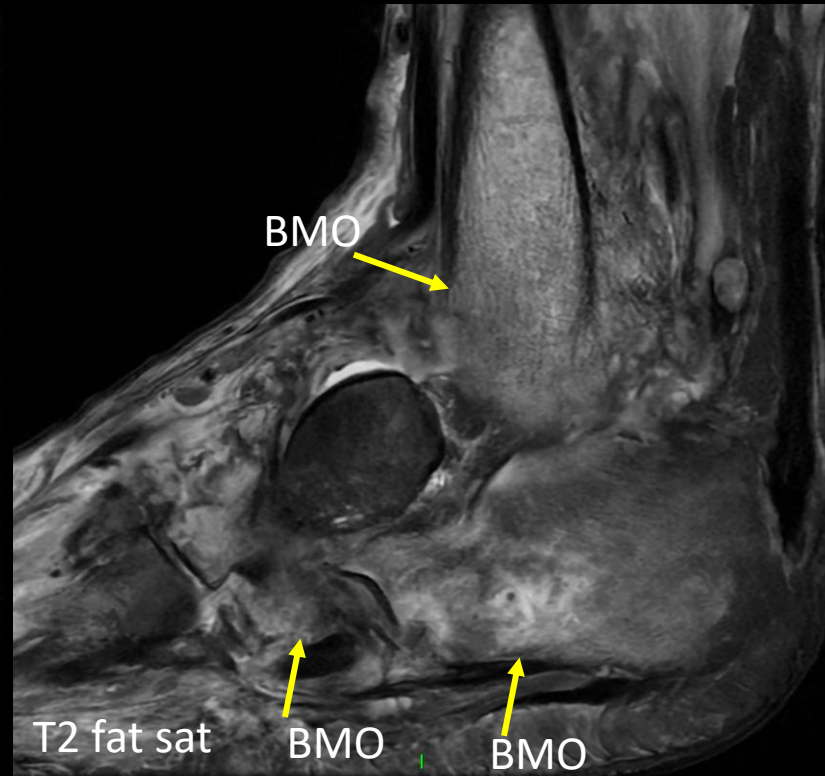
Learning point

Under 18 months old

Transphyseal vessels can spread infection to epiphysis

Diabetic Patient: Osteomyelitis or Charcot?

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Diabetic: Osteomyelitis or Charcot?

Osteomyelitis because affects midfoot

0%

Charcot because affects midfoot

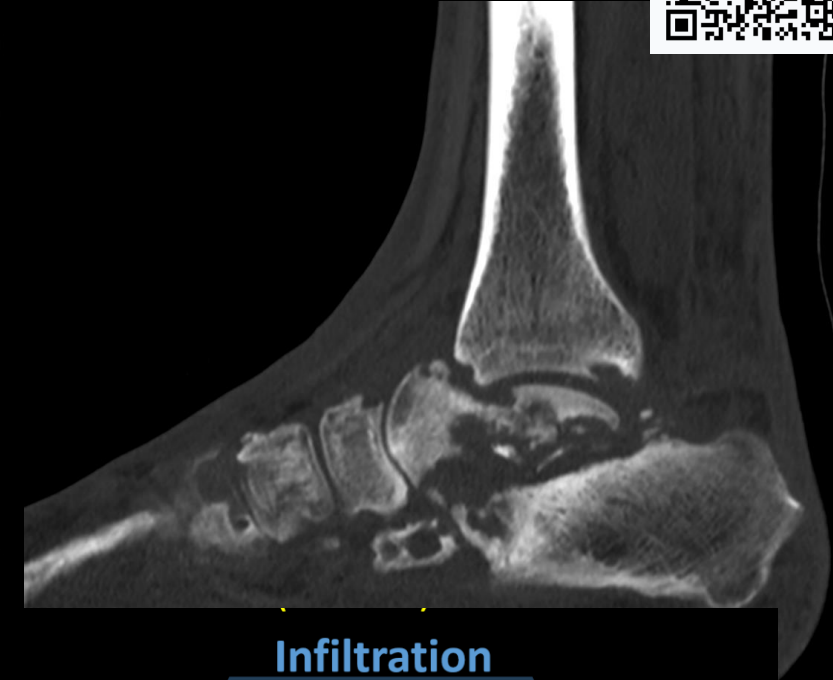
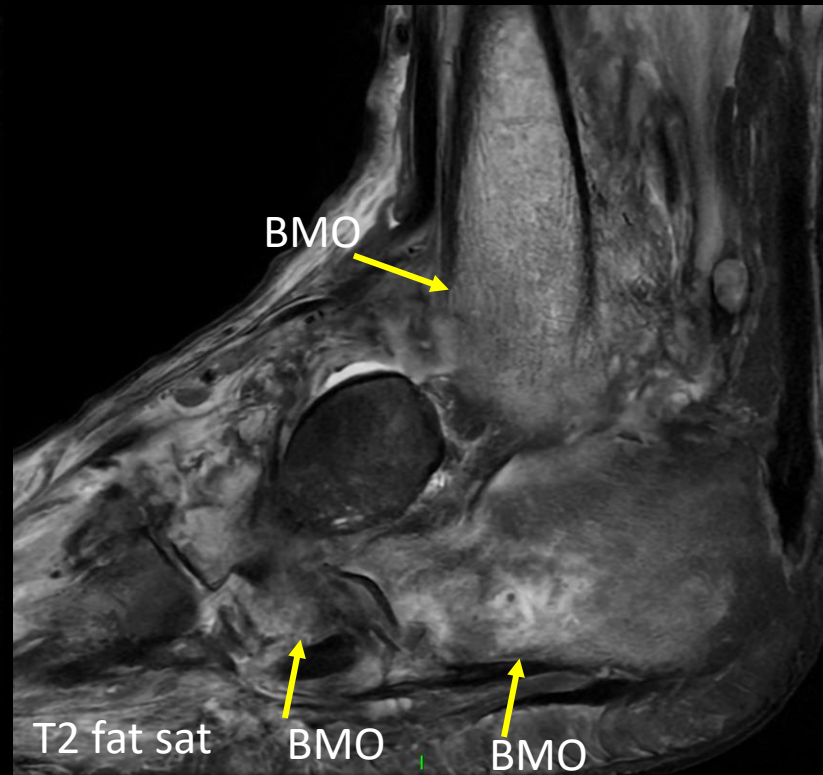
0%

Charcot because disorganised+++

0%

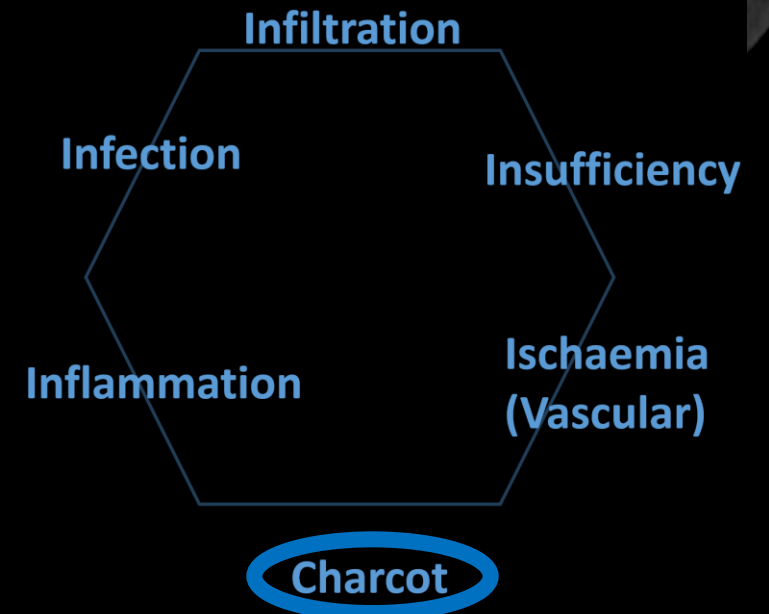
Diabetic Patient: Charcot Neuroarthropathy

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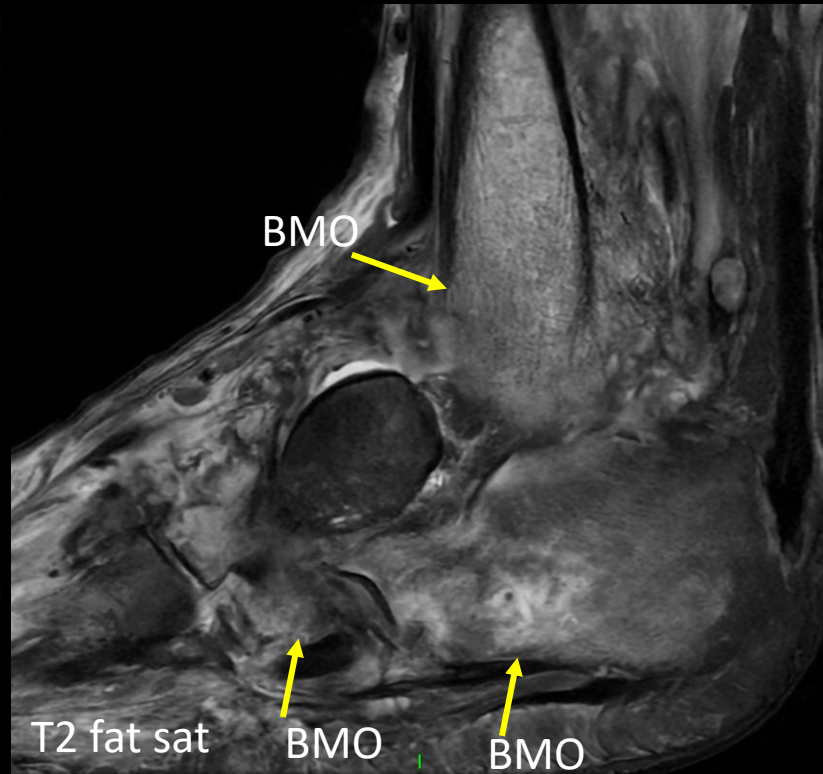


Learning points:Charcot Neuroarthropathy

- Joint-centred
- Usually affects mid-foot (or MTPJoints)



Dx: Charcot neuroarthropathy



CHARCOT – 6 Ds

Density (sclerosis/osteopenia)

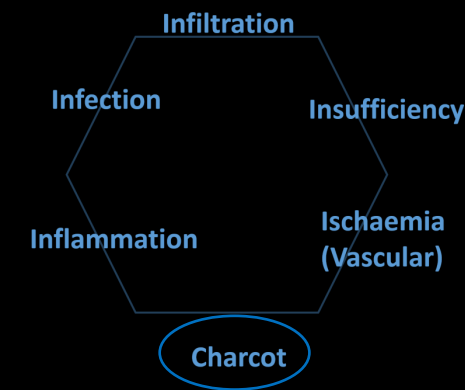
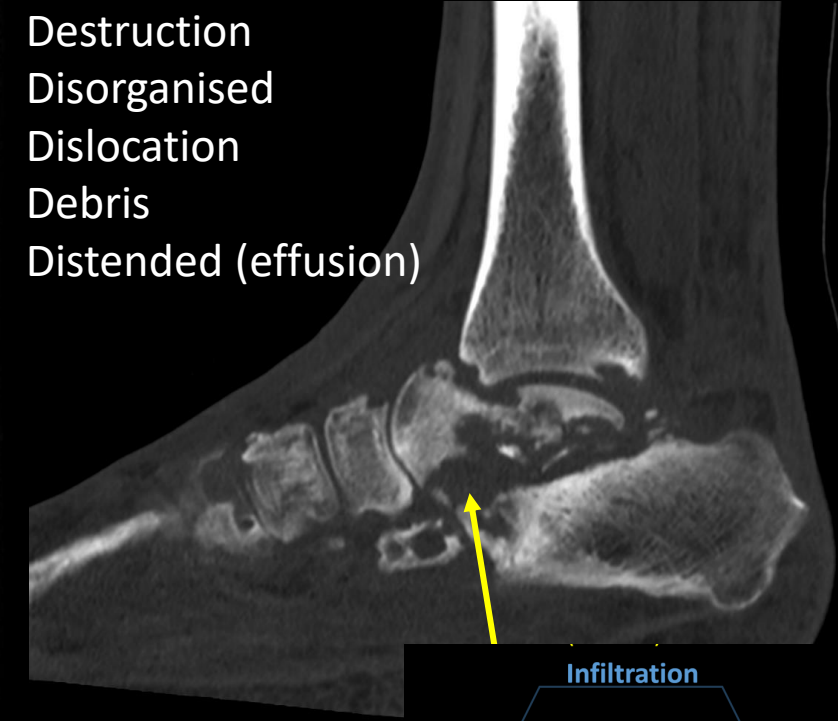
Destruction

Disorganised

Dislocation

Debris

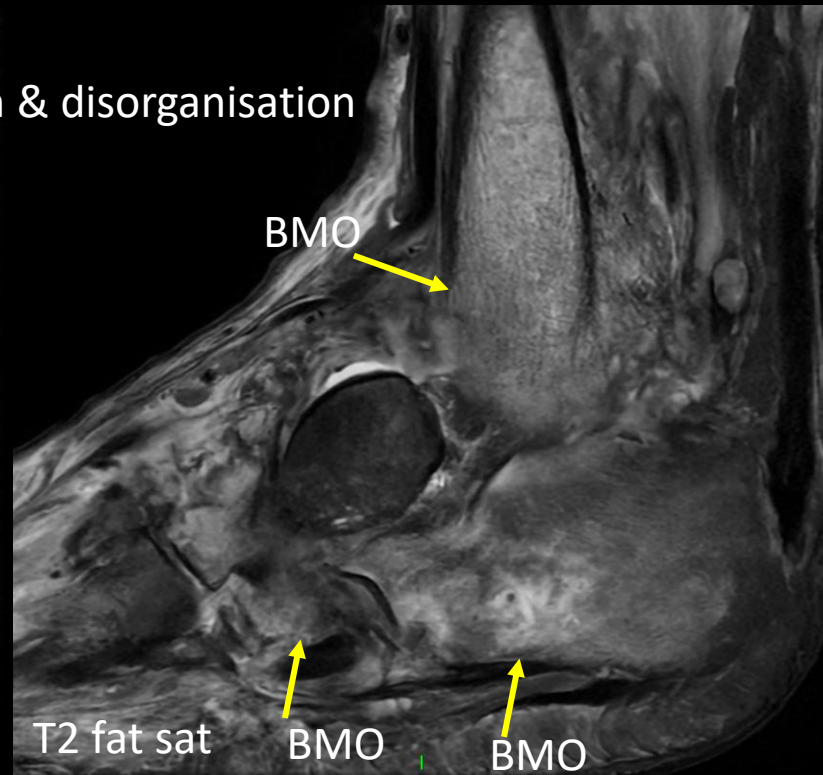
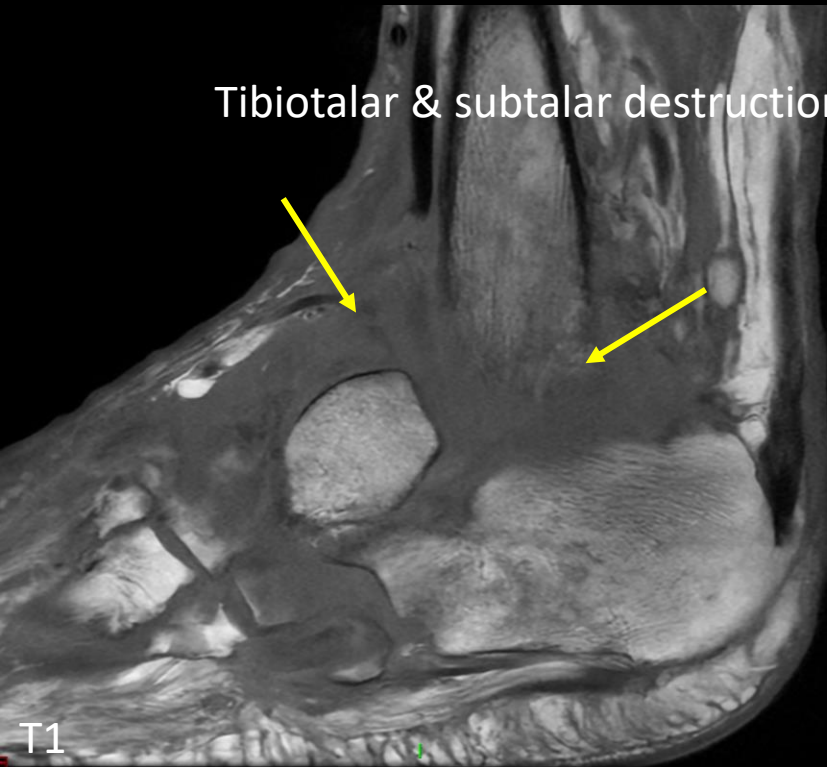
Distended (effusion)



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Dx: Charcot neuroarthropathy



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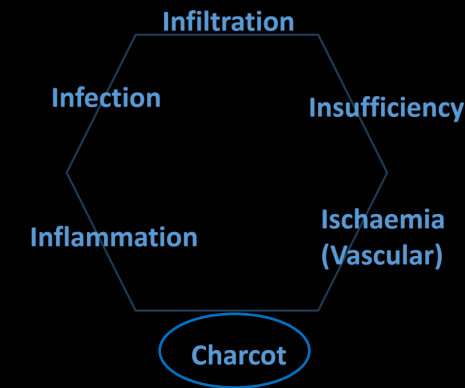
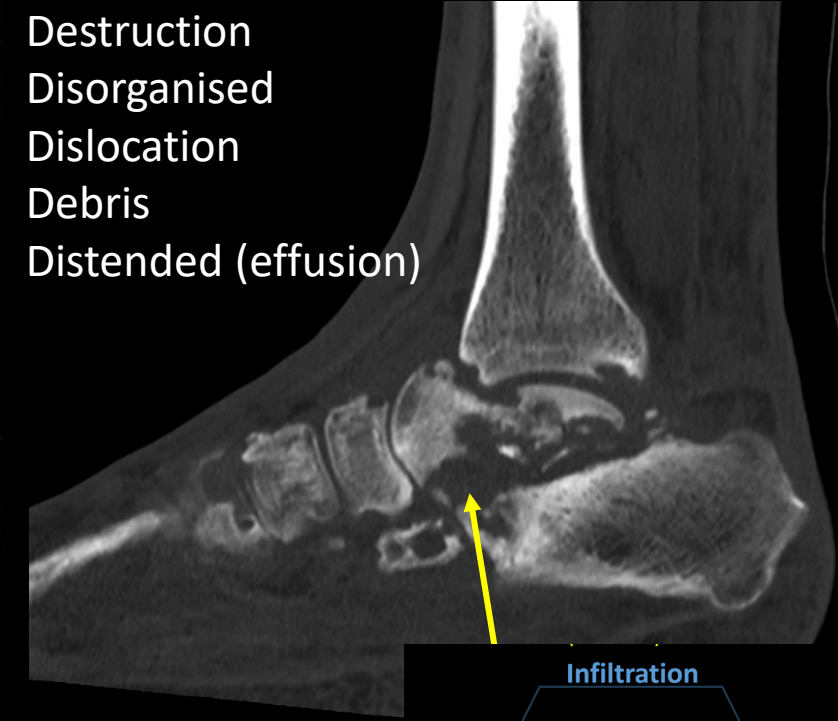
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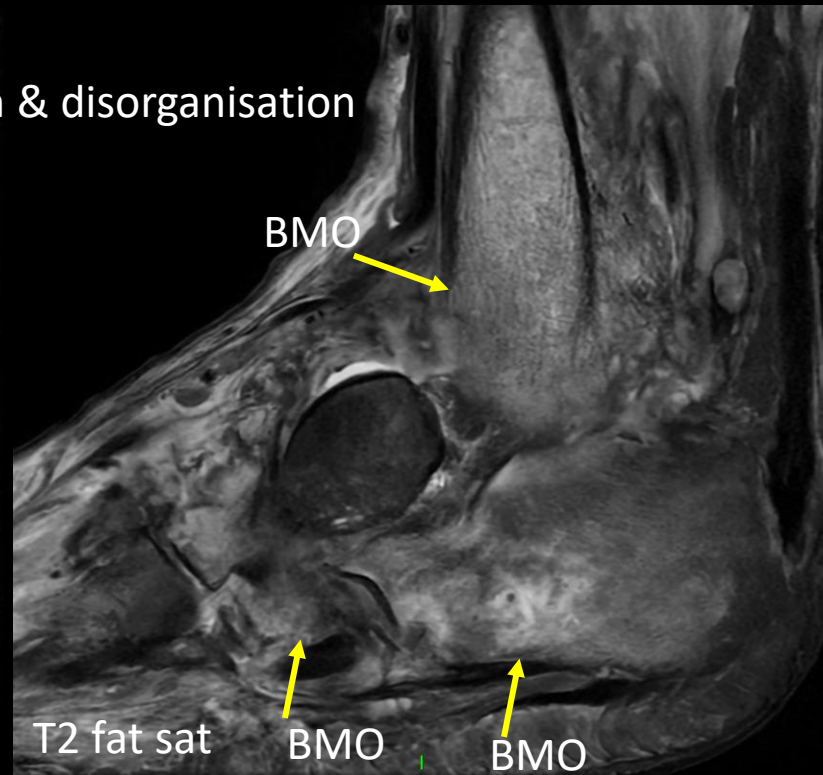
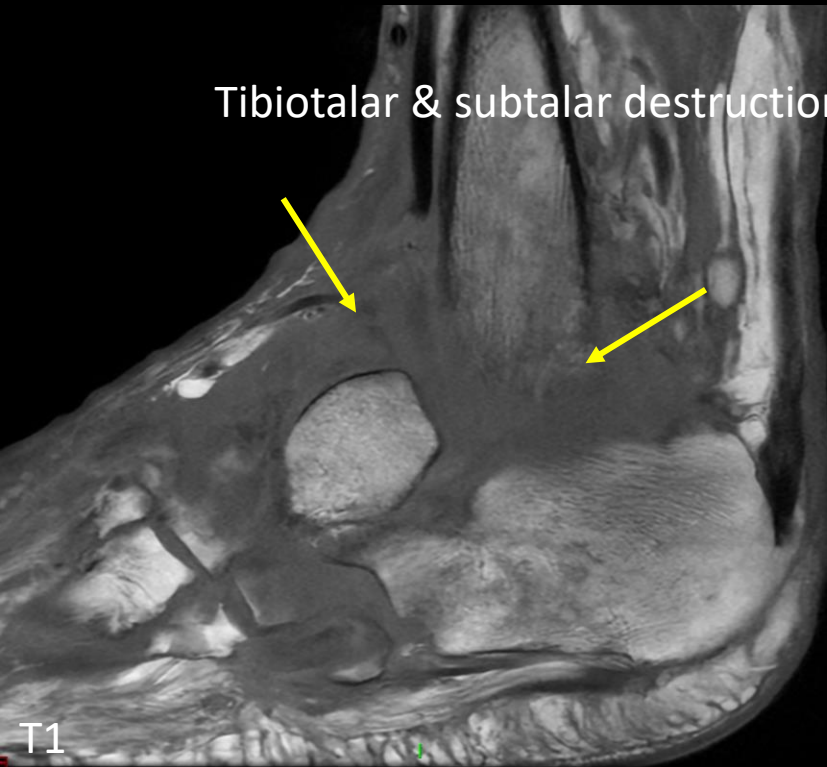
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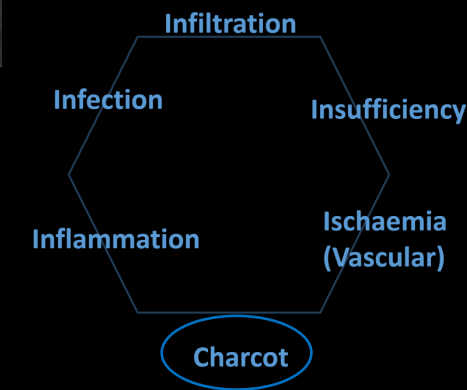
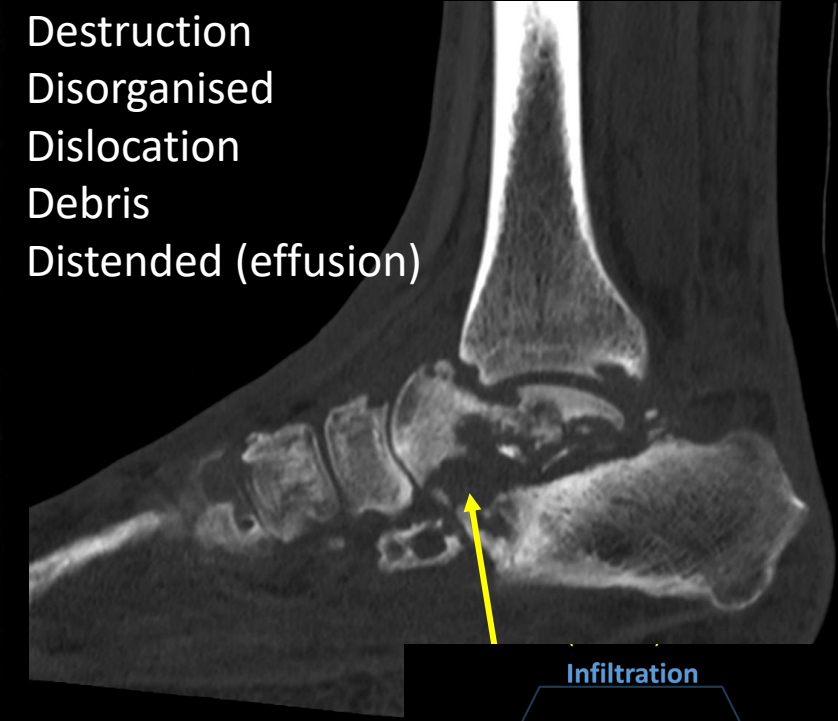
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Distended (effusion)

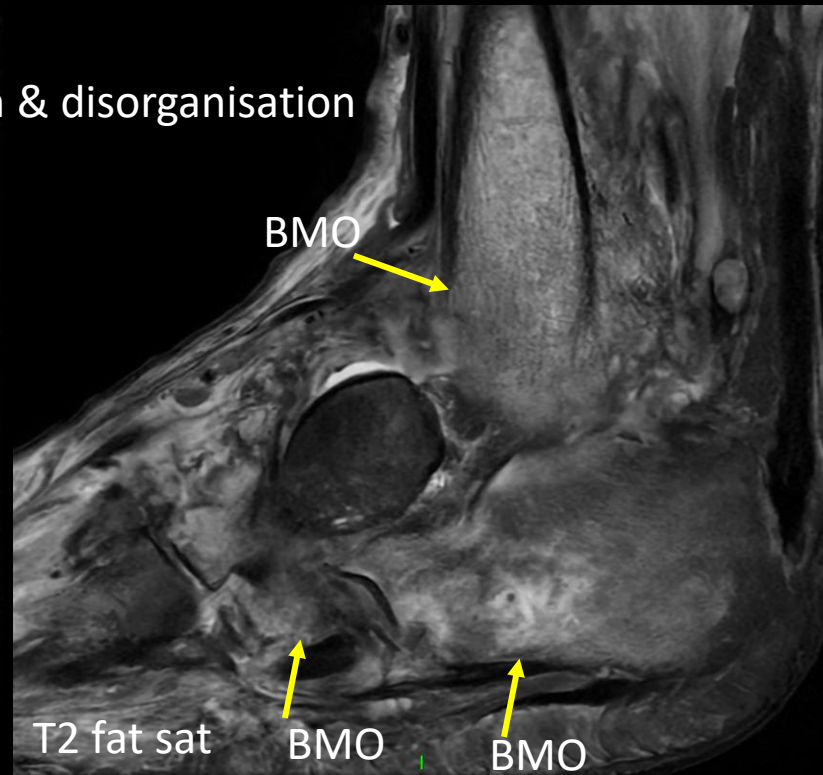
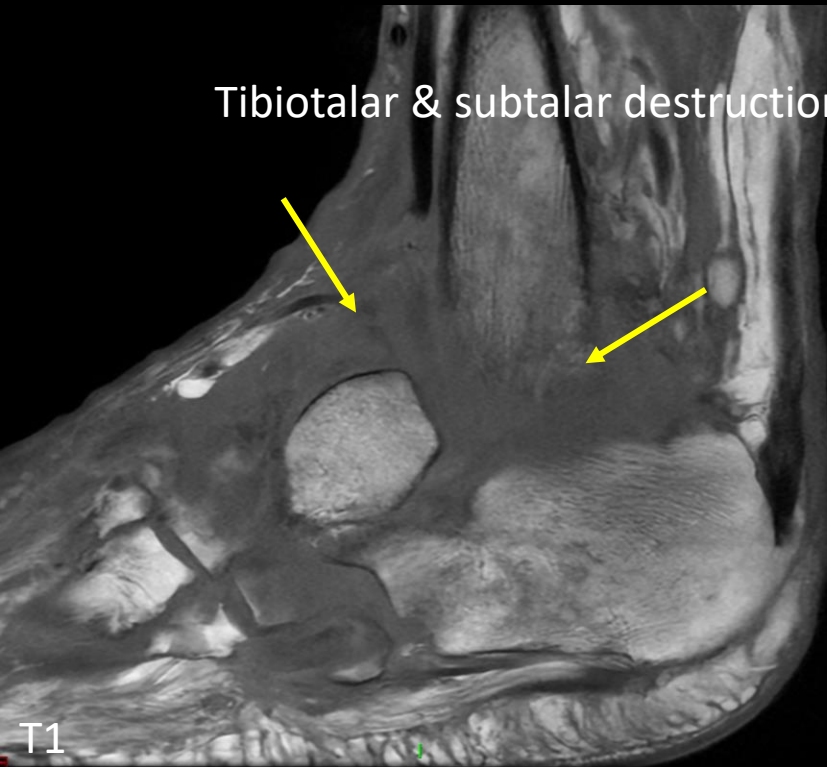


Acute: subcutaneous oedema, effusions, bone marrow oedema

Subacute: bone resorption

Chronic: Deformity, osseous fragmentation

Dx: Charcot neuroarthropathy



CHARCOT – 6 Ds

Density (sclerosis/osteopenia)

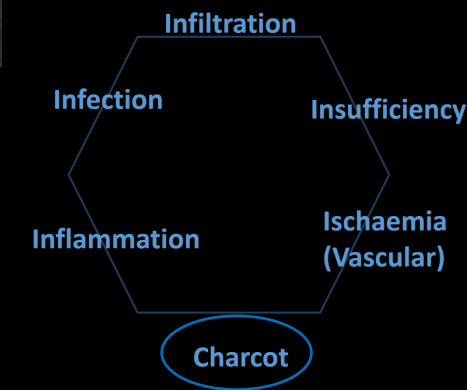
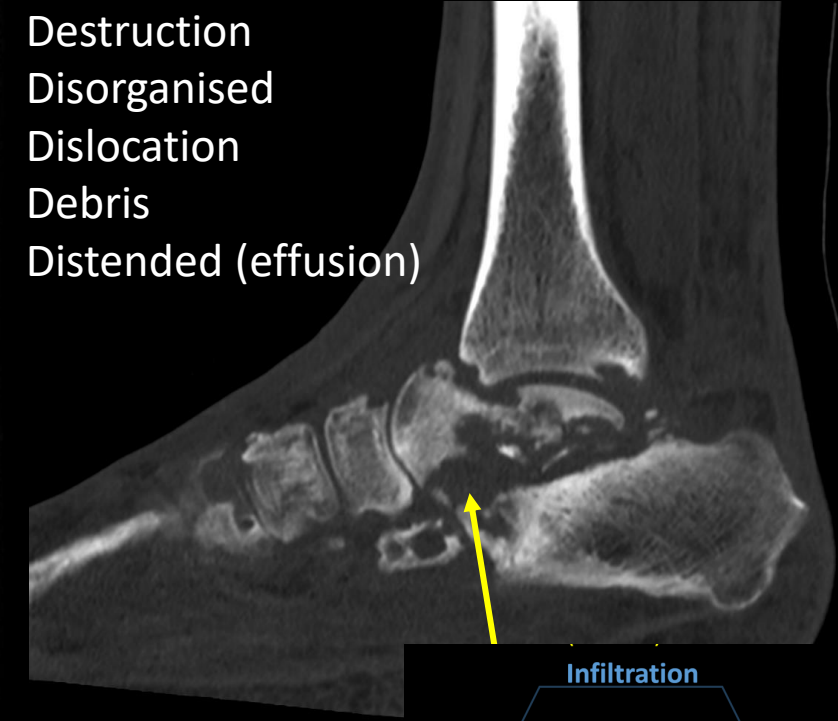
Destruction

Disorganised

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Distended (effusion)

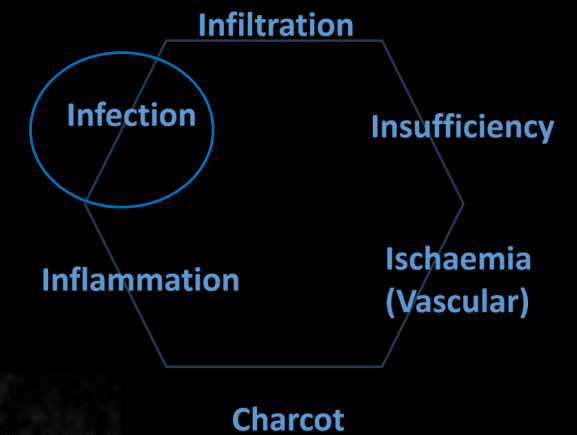


Acute: subcutaneous oedema, effusions, bone marrow oedema

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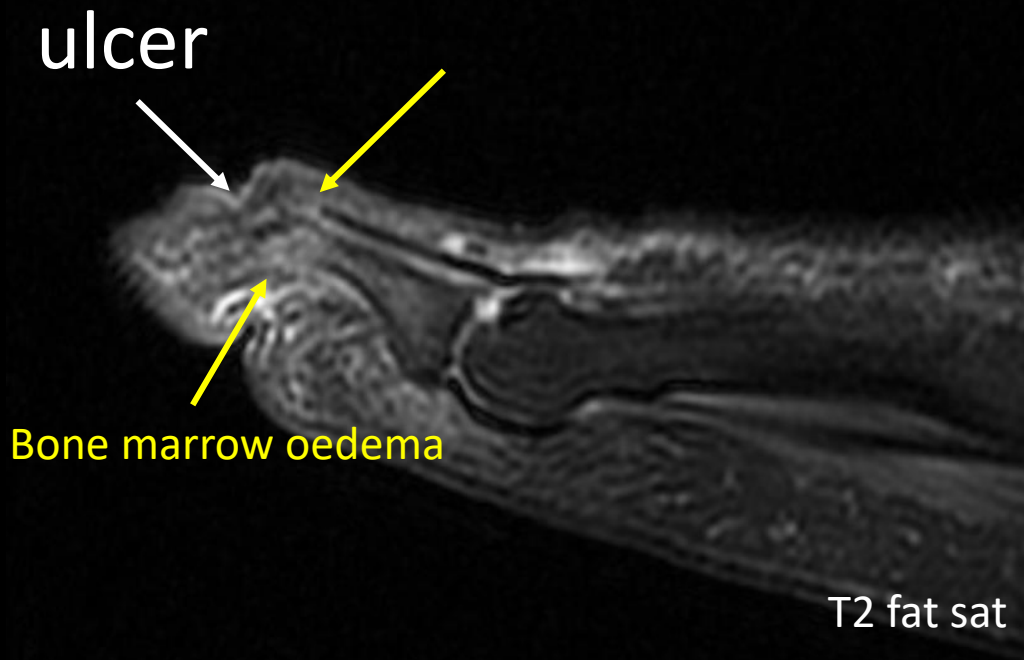
Companion Cases: Diabetic osteomyelitis



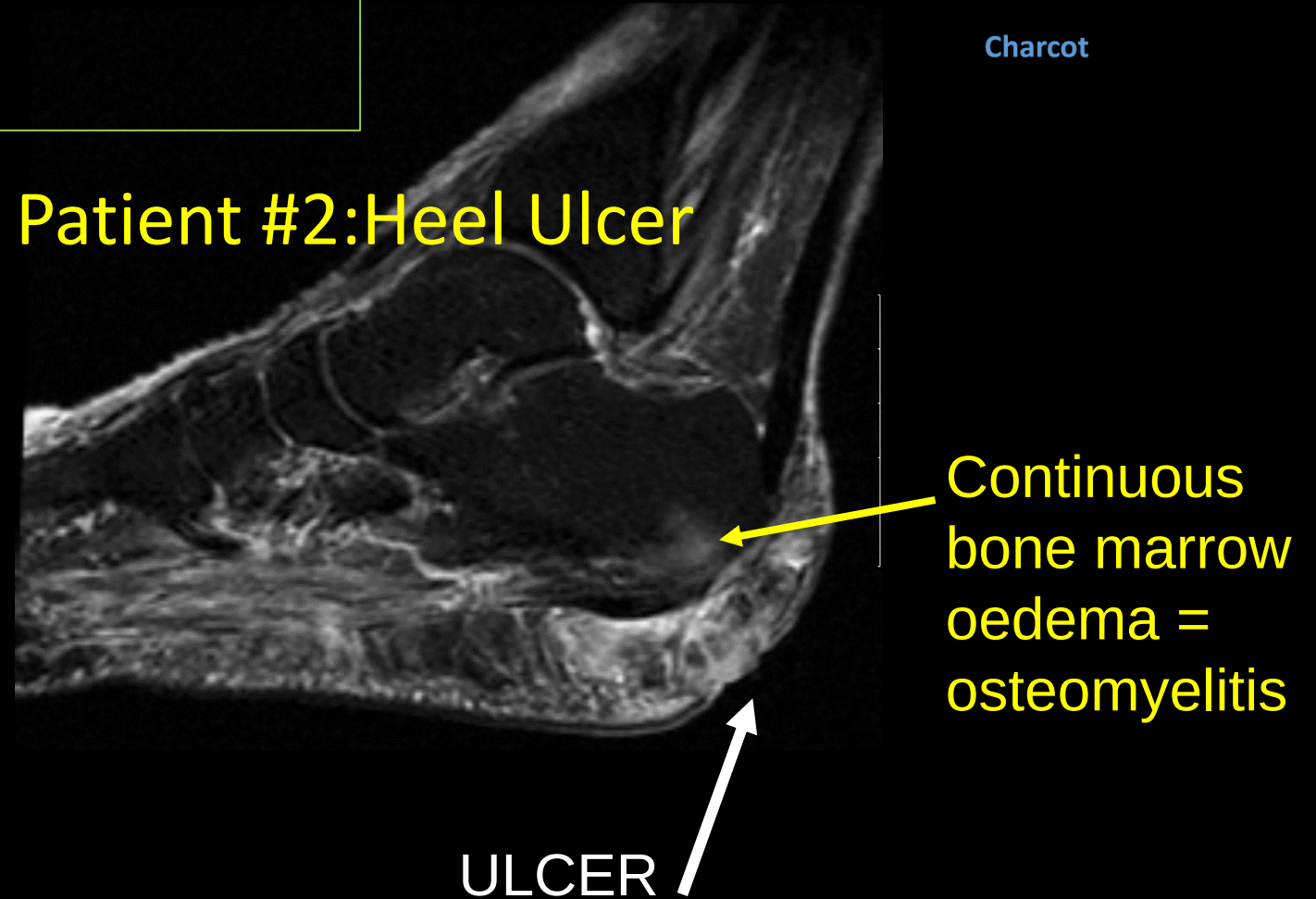
Learning points: Diabetic osteomyelitis

- Affects toes and heel
- Infection spreads directly: Look for ulceration, follow the path
- Use homogenous T2 fat sat (eg STIR)
- Skin marker useful

Patient #1: 5th toe

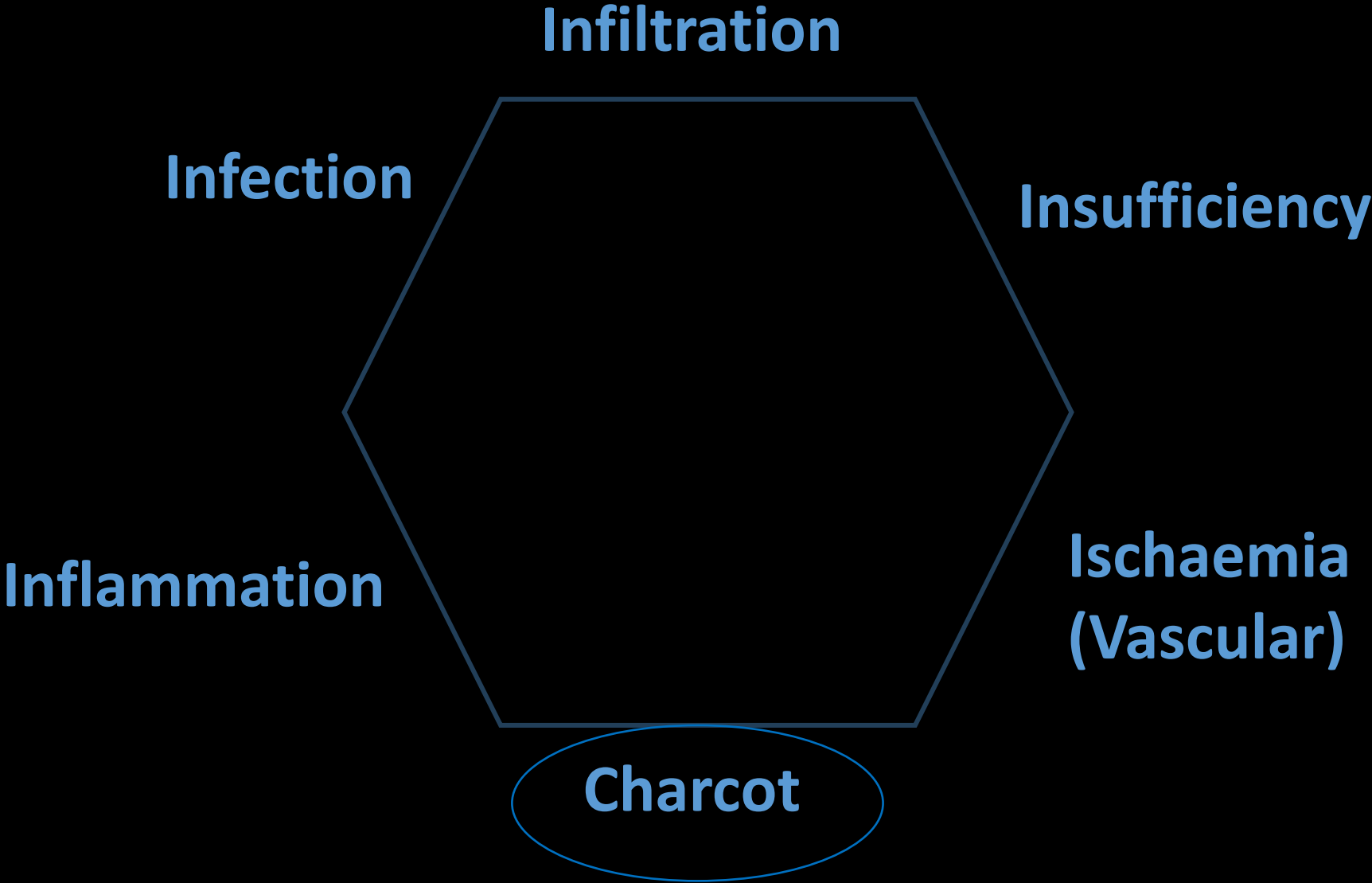


Patient #2: Heel Ulcer



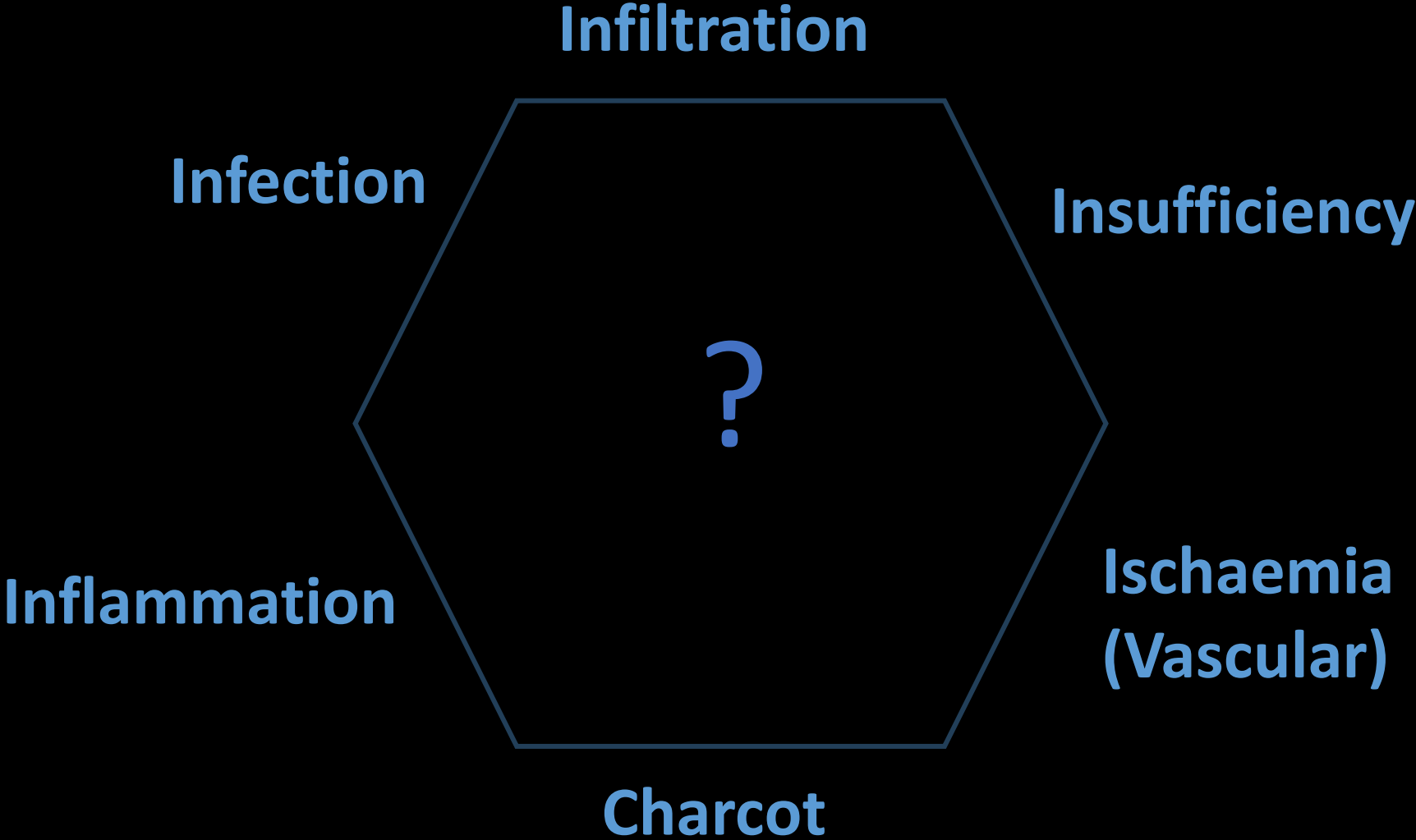


Causes of Bone Marrow Oedema (BMO)





Causes of Bone Marrow Oedema (BMO)



80 yo male, back pain



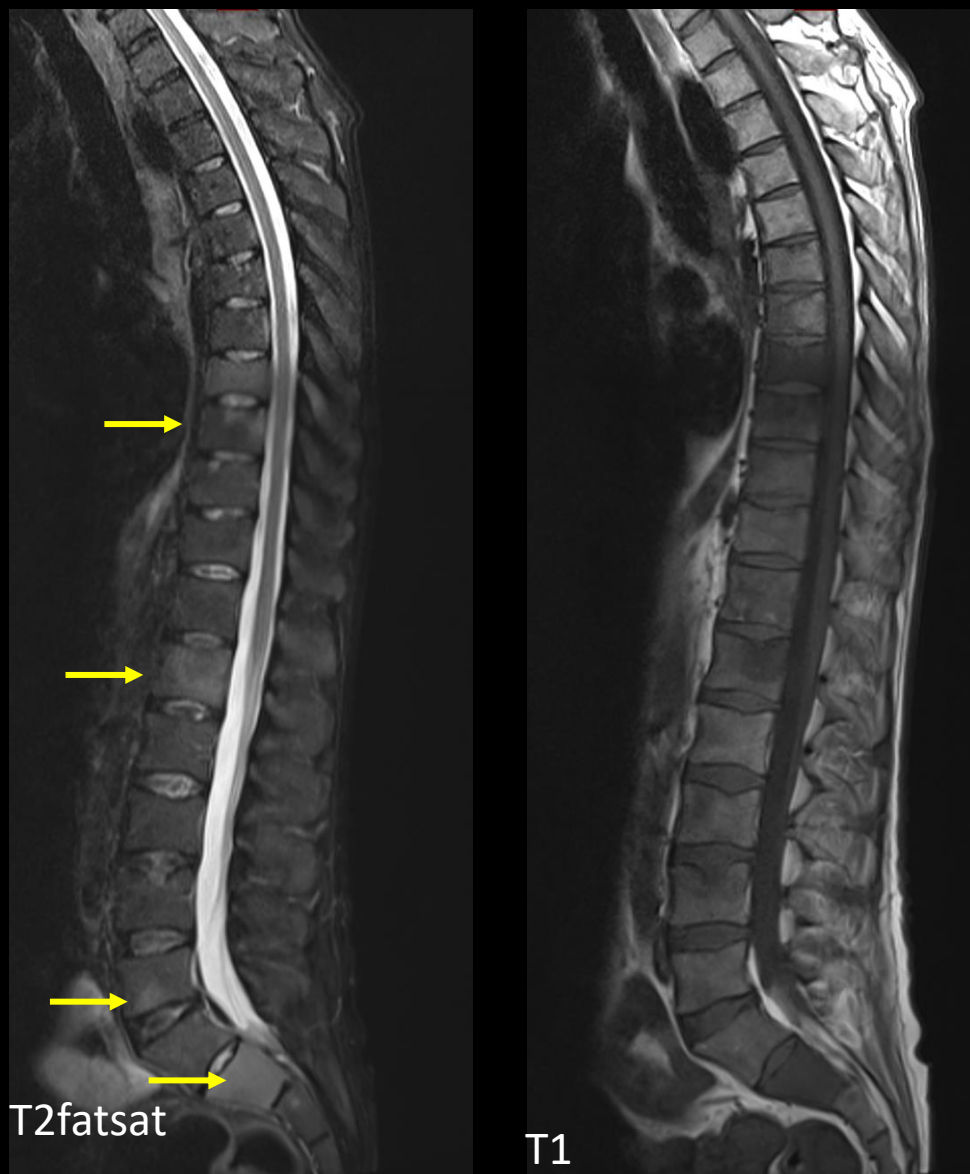
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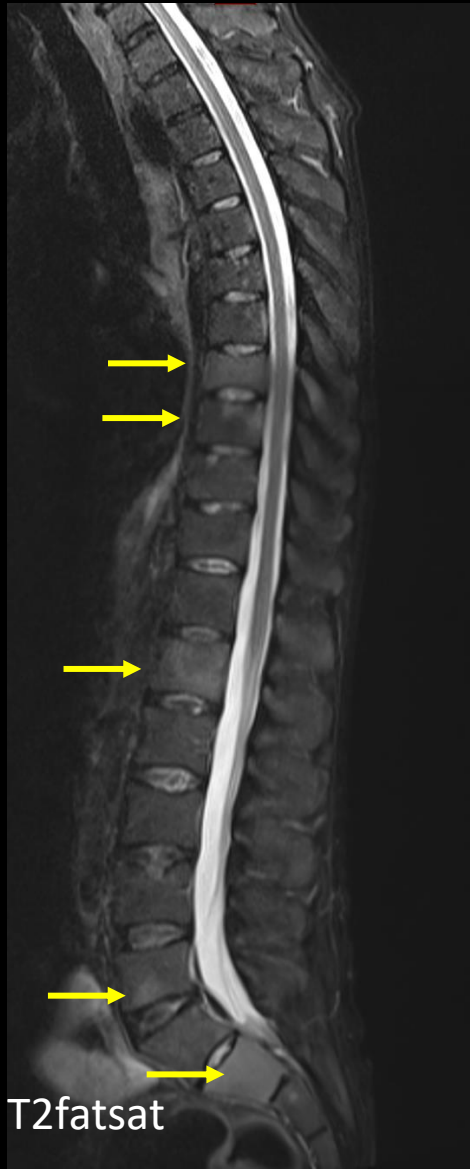
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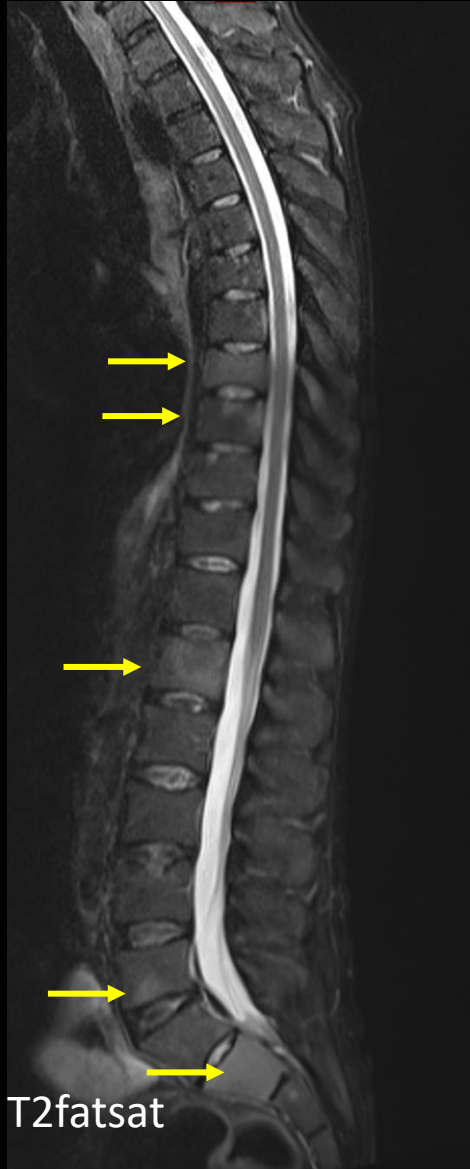
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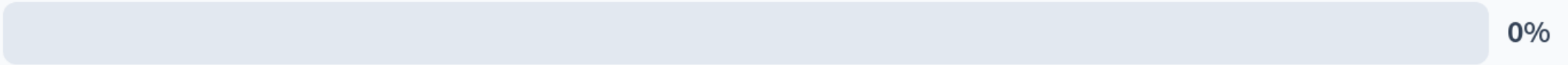


80 yo male, back pain

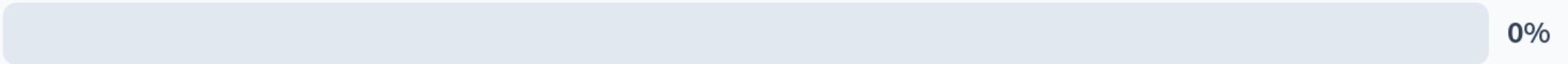


What is the diagnosis

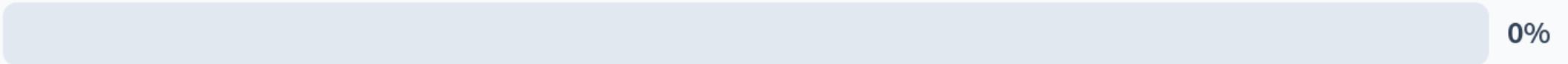
Infection



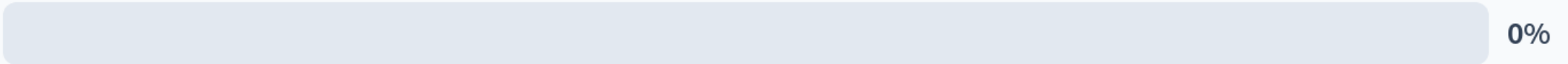
Inflammation



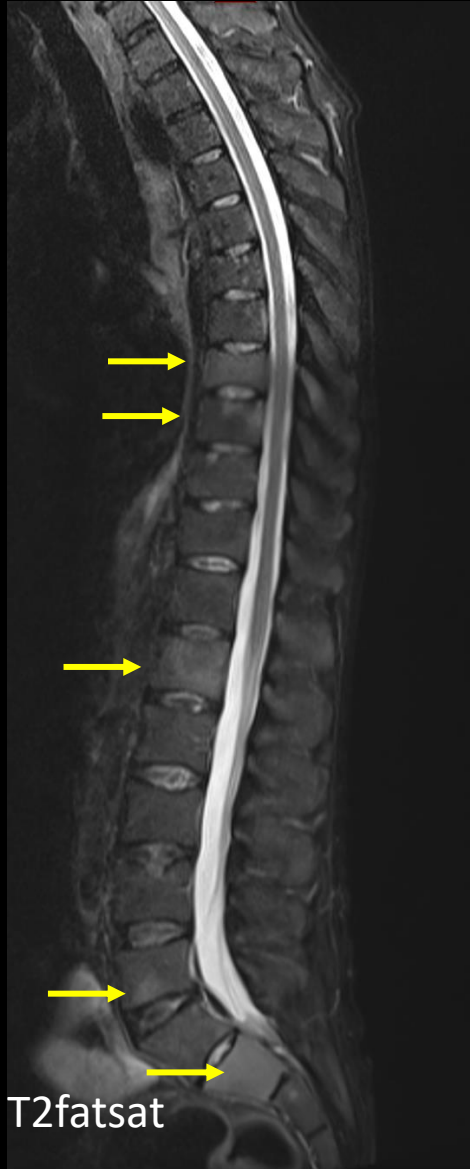
Infiltration



Ischaemia

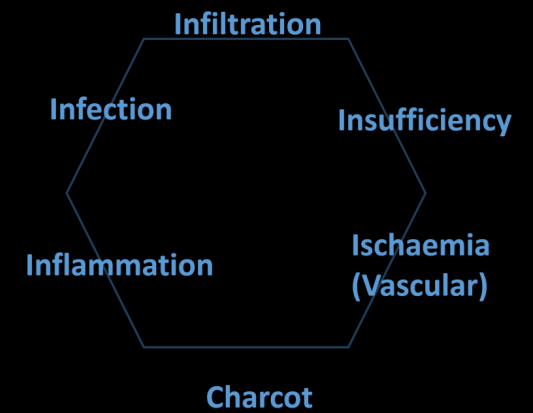
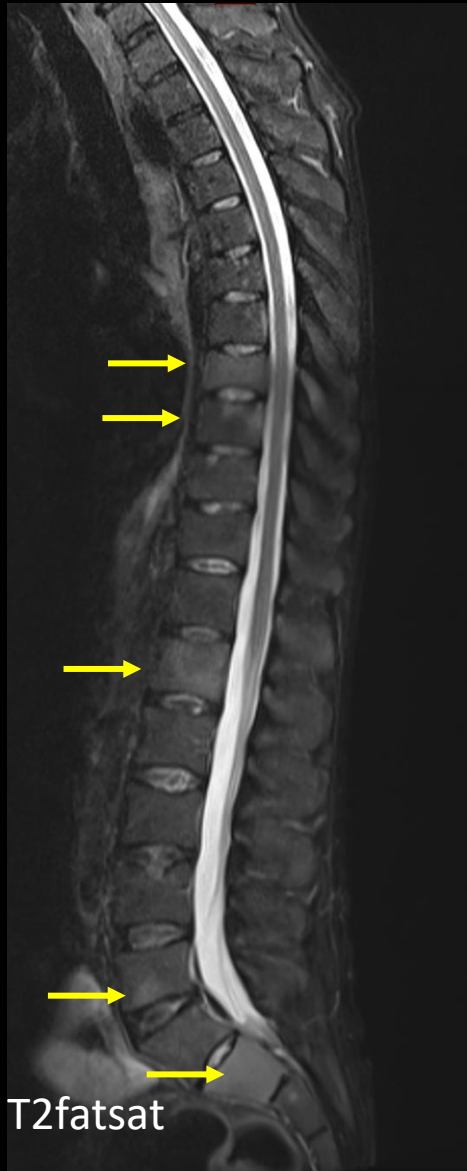


80 yo male, back pain



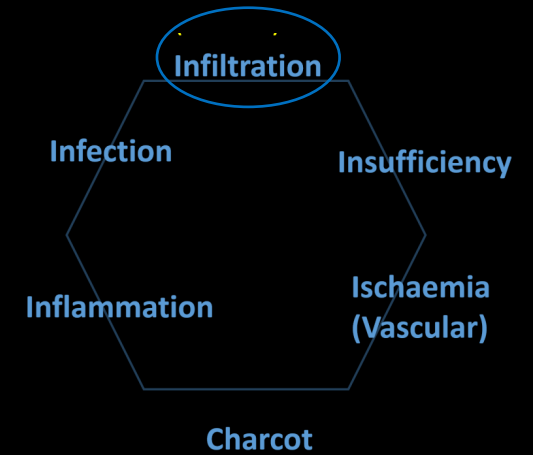
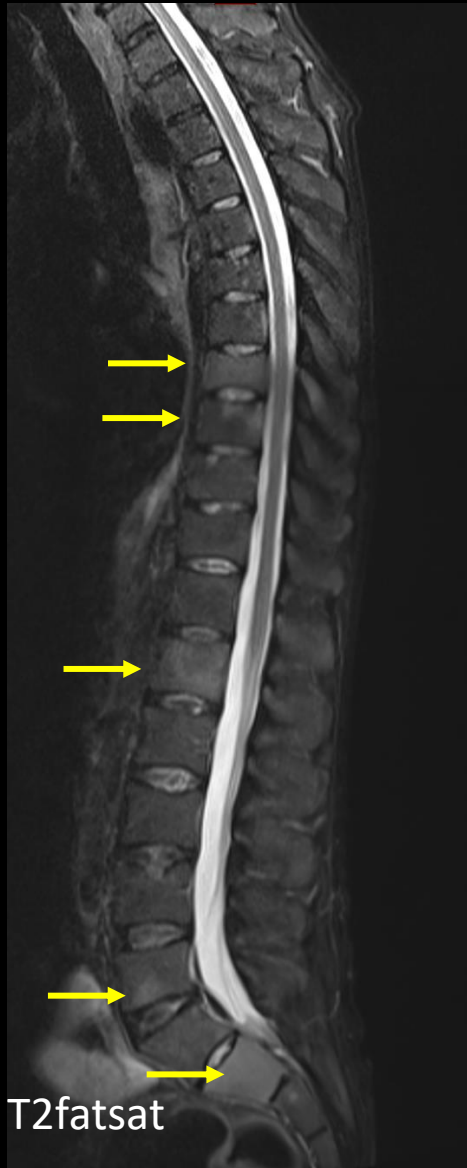
Dx: Sclerotic metastases with bone marrow oedema

80 yo male, back pain



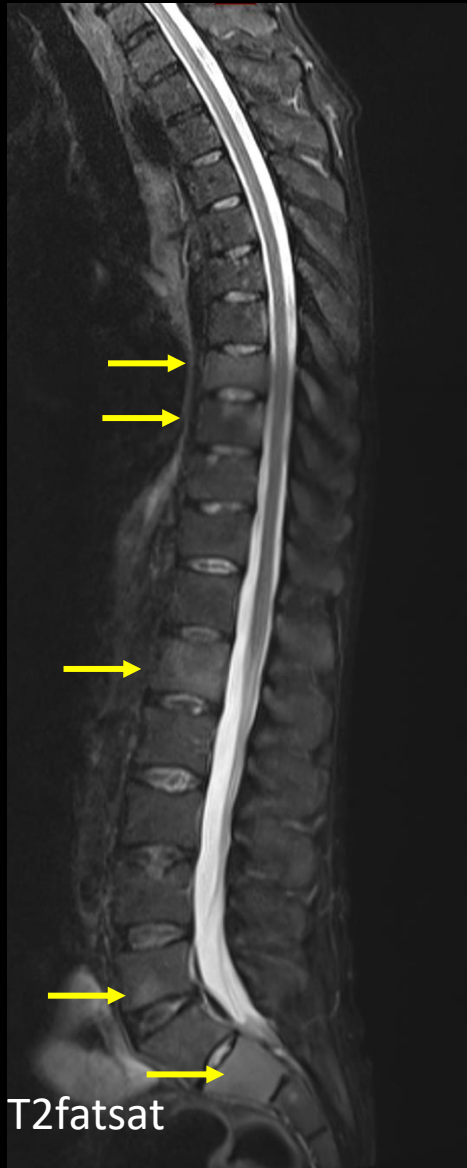
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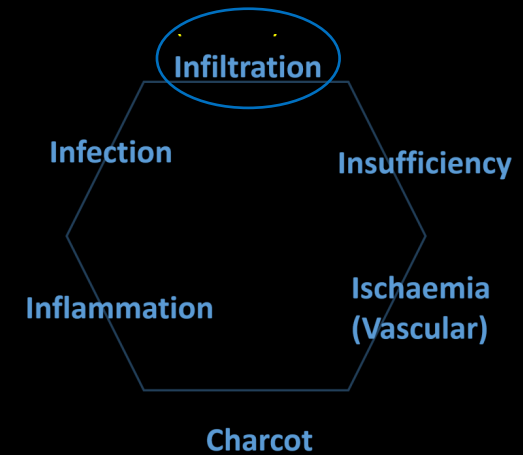
Dx: Sclerotic metastases with bone marrow oedema

80 yo male, back pain



Learning point

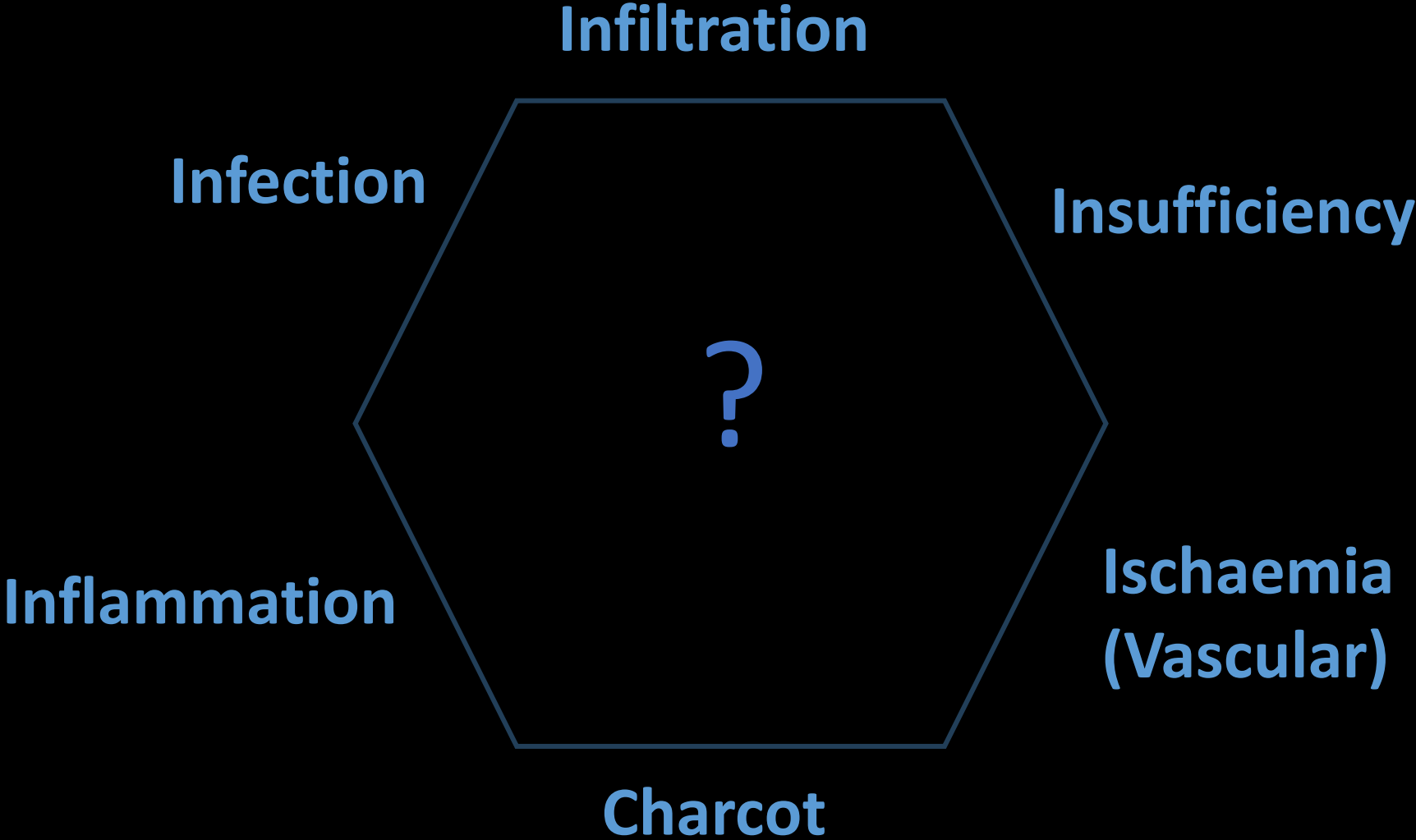
Use CT to identify sclerotic and lytic metastases



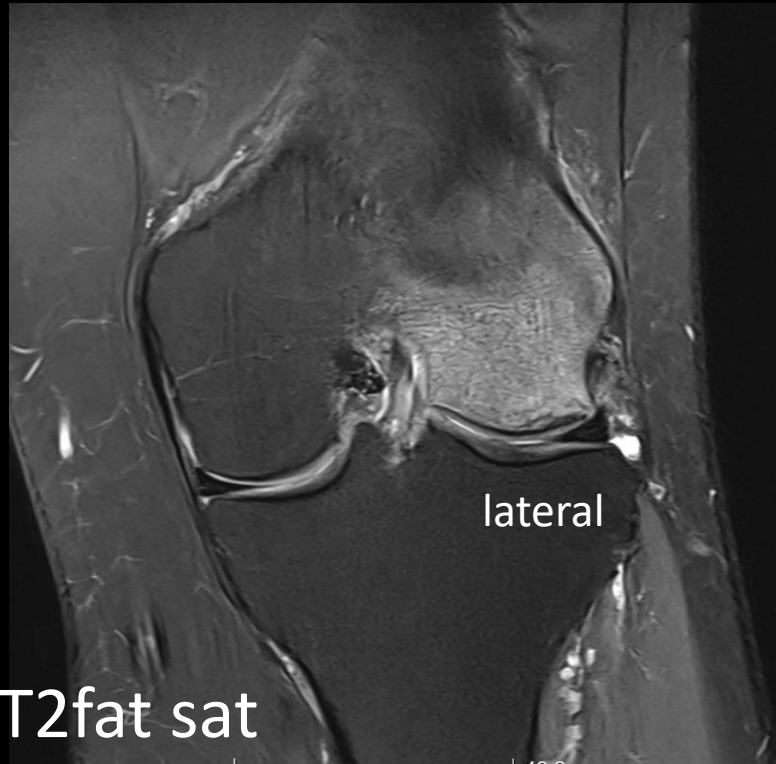
Dx: Sclerotic metastases with bone marrow oedema



Causes of Bone Marrow Oedema (BMO)



60 yo female. No trauma. Sudden onset lateral knee pain. What is the diagnosis/differential diagnosis?



What is the diagnosis/differential diagnosis

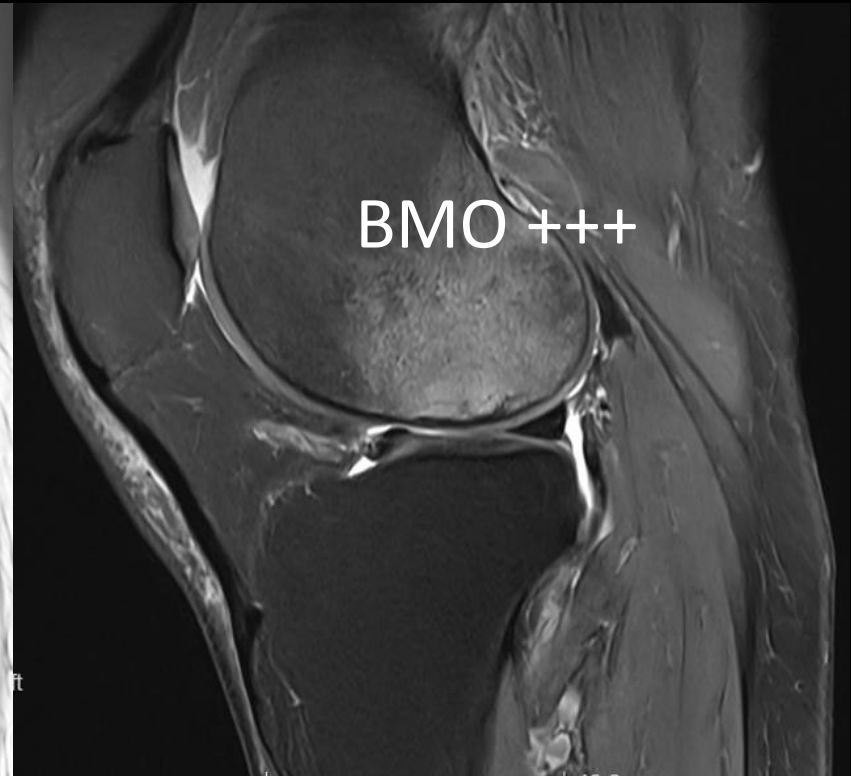
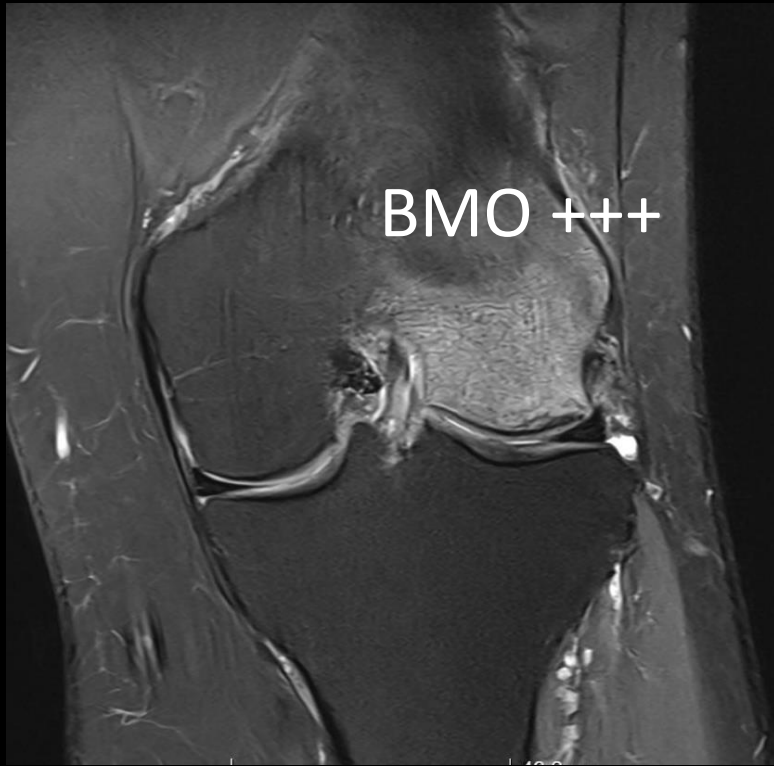
Nobody has responded yet.

Hang tight! Responses are coming in.

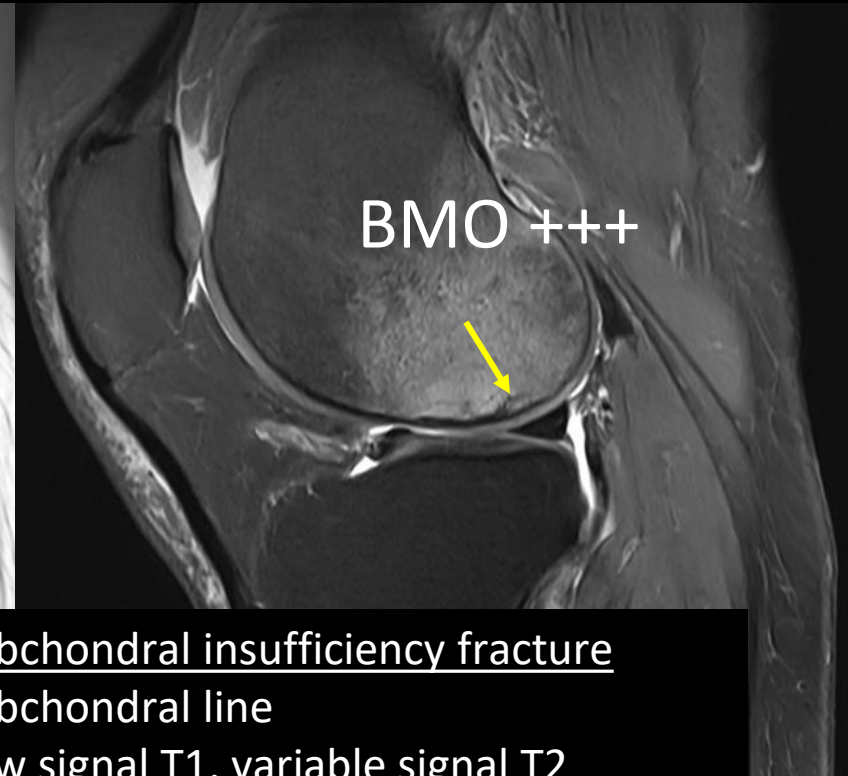
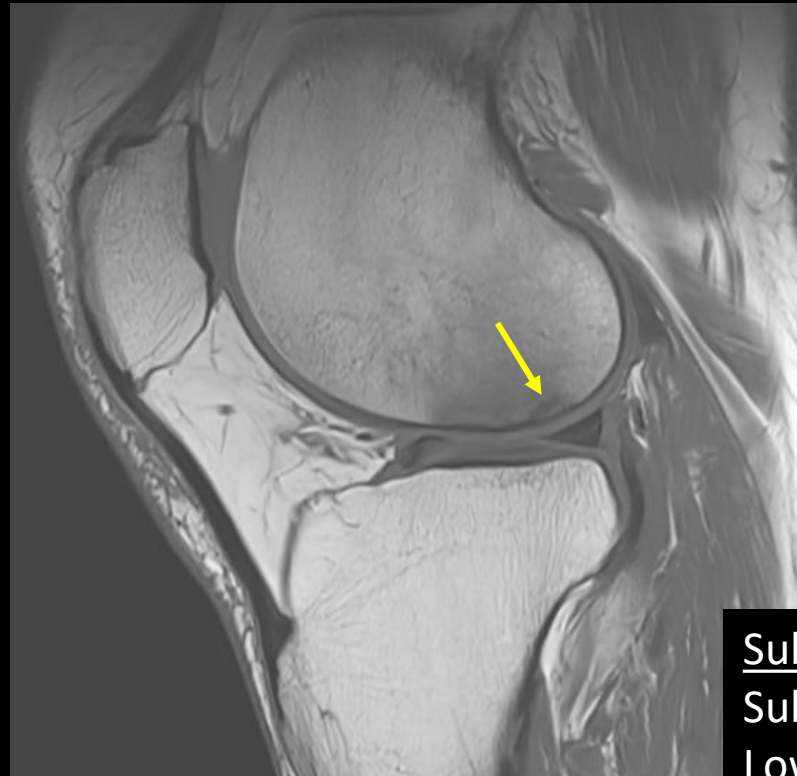
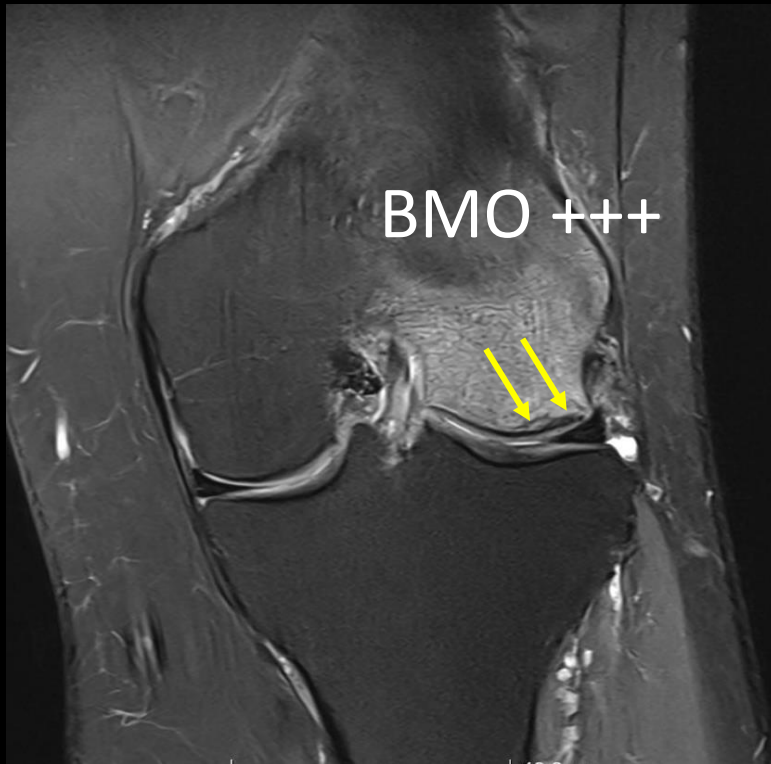
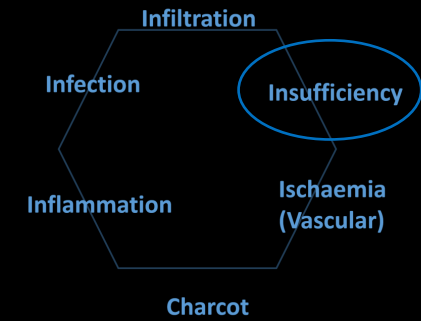
Differential diagnosis:
Transient osteoporosis, Subchondral insufficiency
fracture, Avascular Necrosis



Differential diagnosis:
Transient osteoporosis, Subchondral insufficiency
fracture, Avascular Necrosis



Dx: Subchondral insufficiency Fracture (SIF)



Subchondral insufficiency fracture

Subchondral line

Low signal T1, variable signal T2

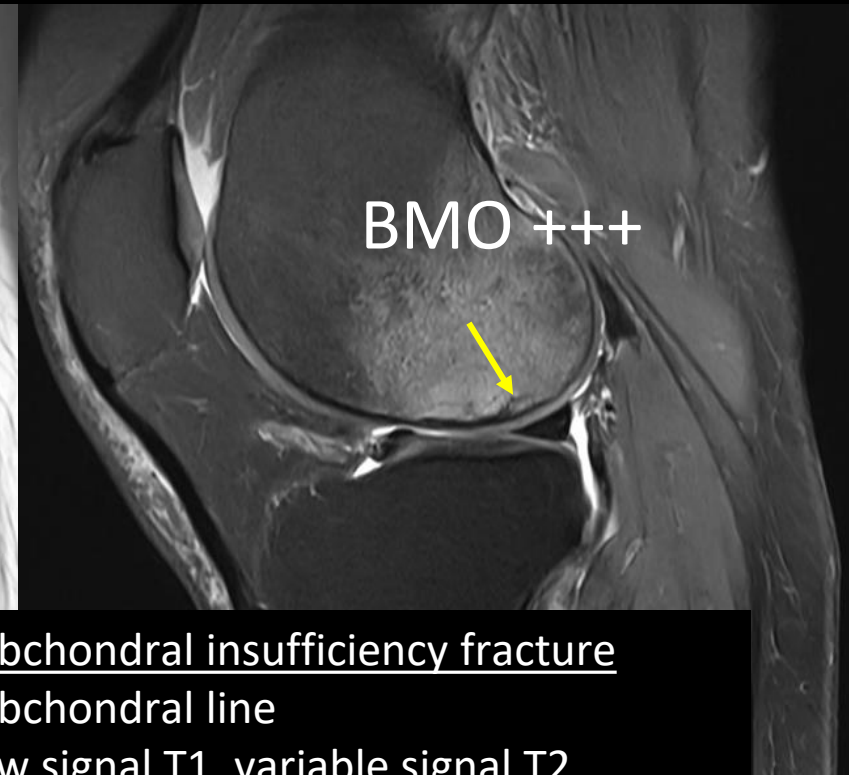
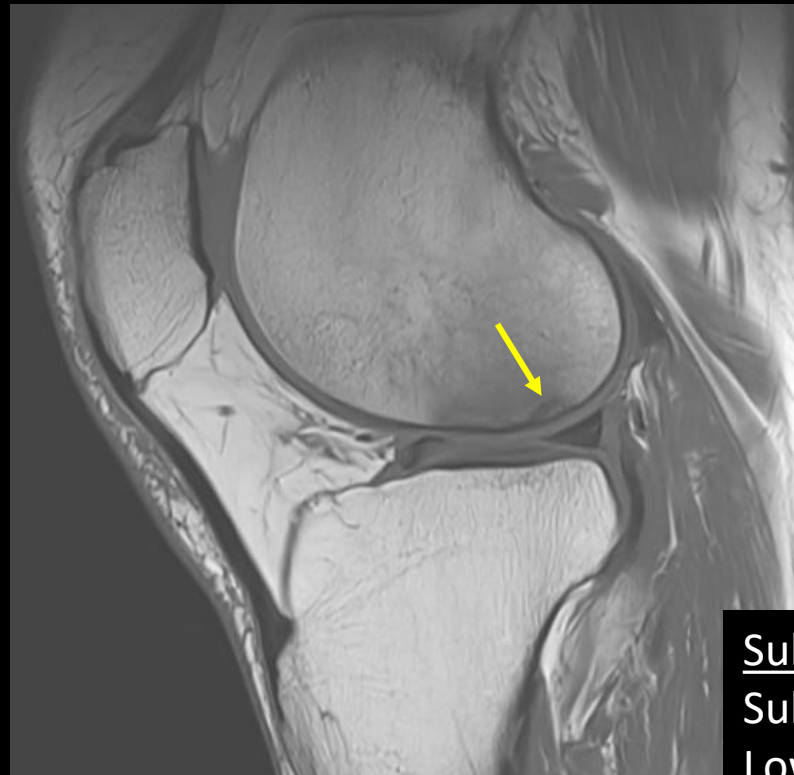
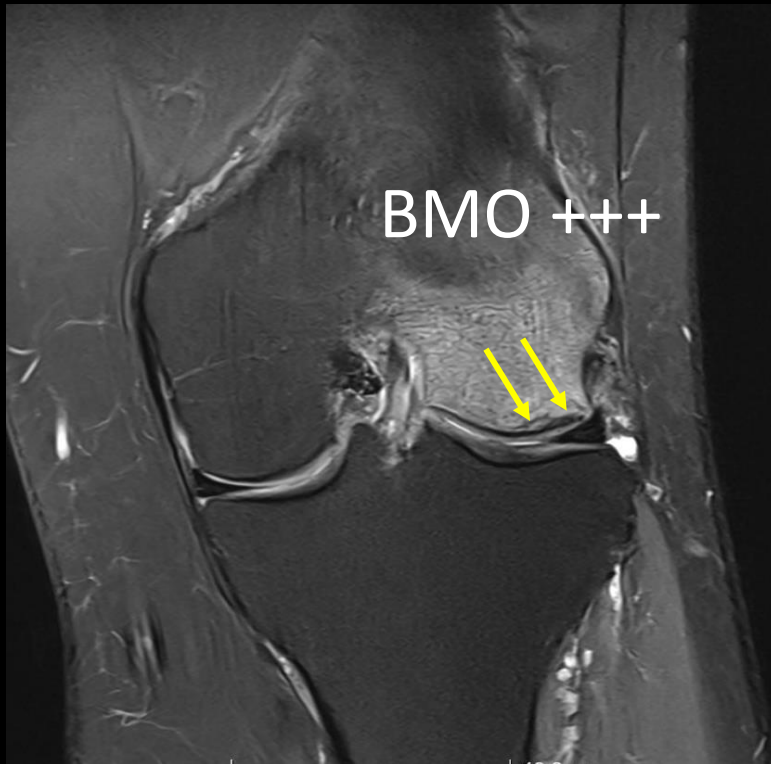
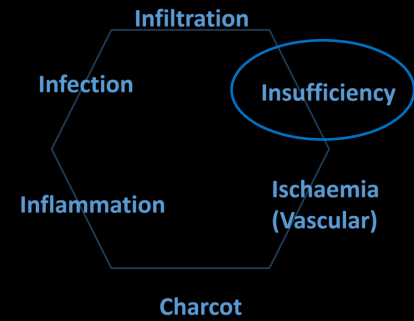
Separate to but subjacent to bone plate

Surrounded by +++ BMO

Dx: Subchondral insufficiency Fracture (SIF)

LEARNING POINT: SUBCHONDRAL INSUFFICIENCY FRACTURE VS AVN

Subchondral insufficiency fracture is thinner and less geographic than AVN



Subchondral insufficiency fracture

Subchondral line

Low signal T1, variable signal T2

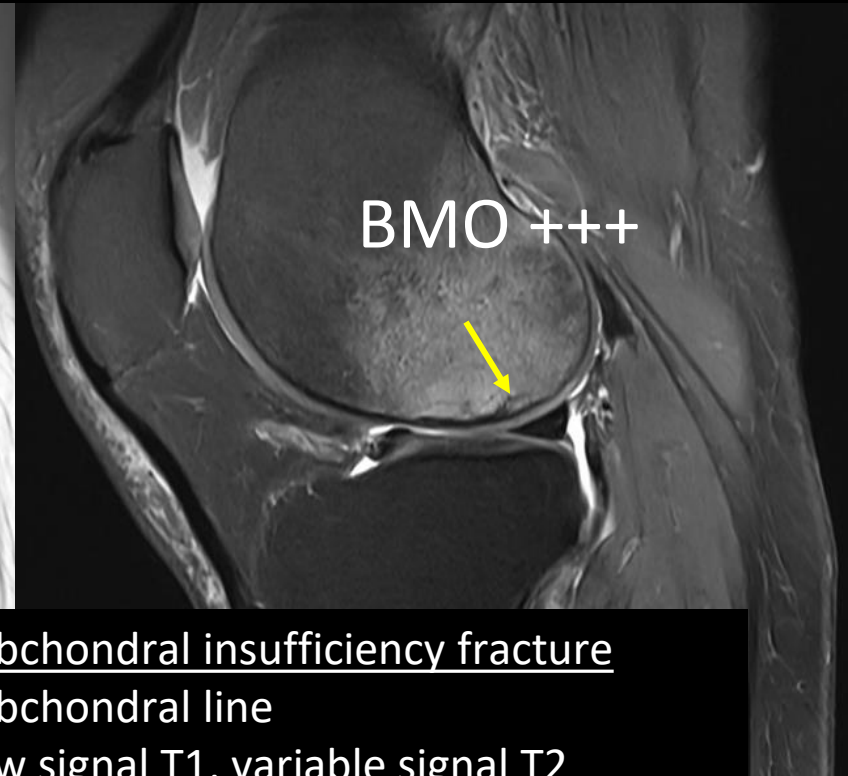
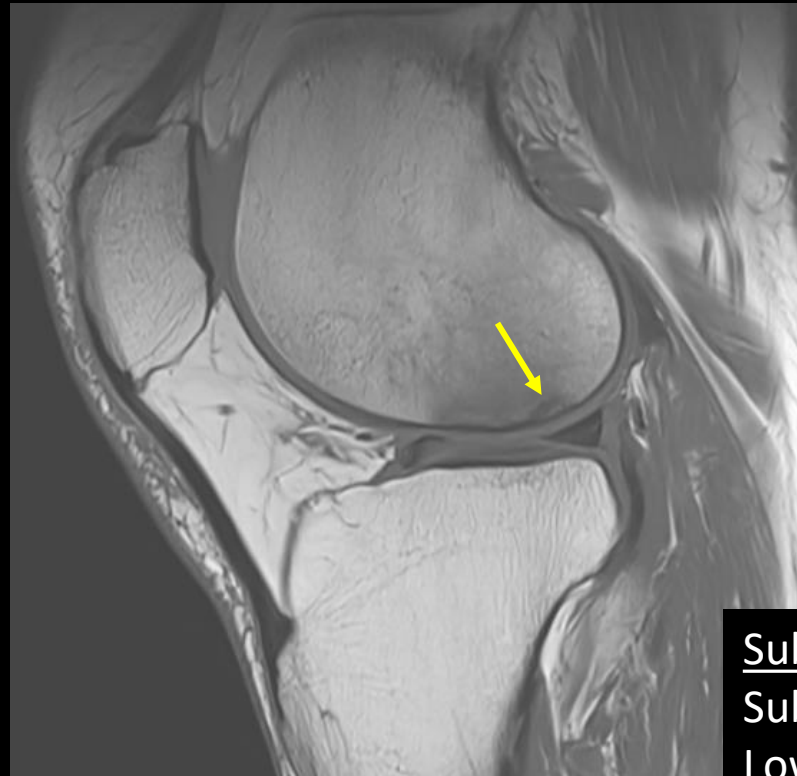
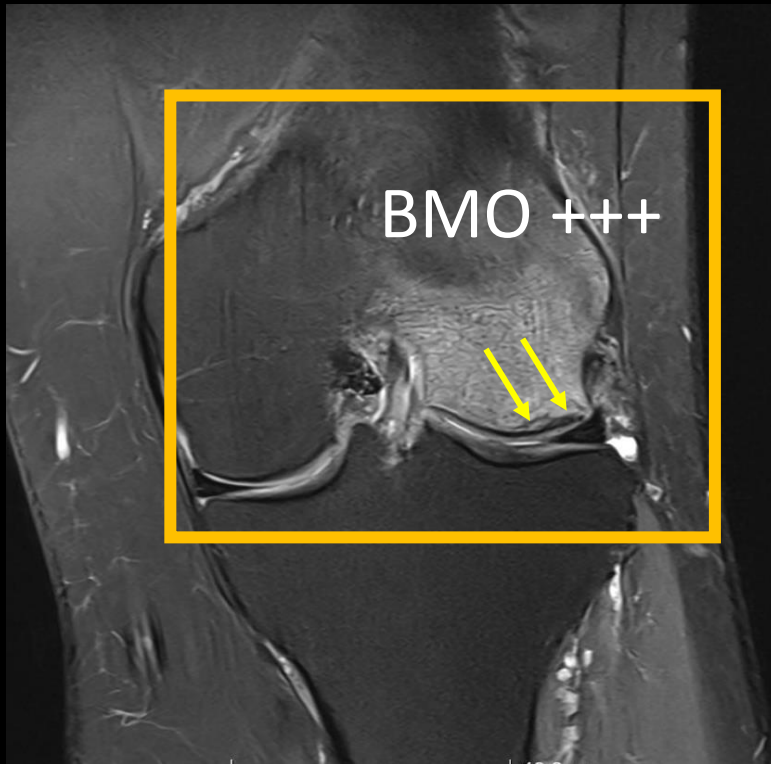
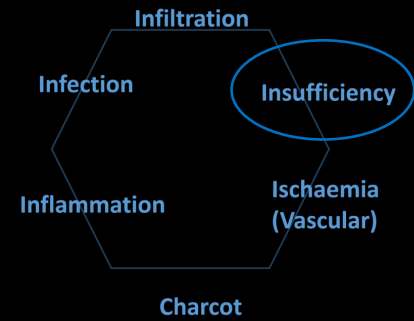
Separate to but subjacent to bone plate

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Subchondral insufficiency fracture

Subchondral line

Low signal T1, variable signal T2

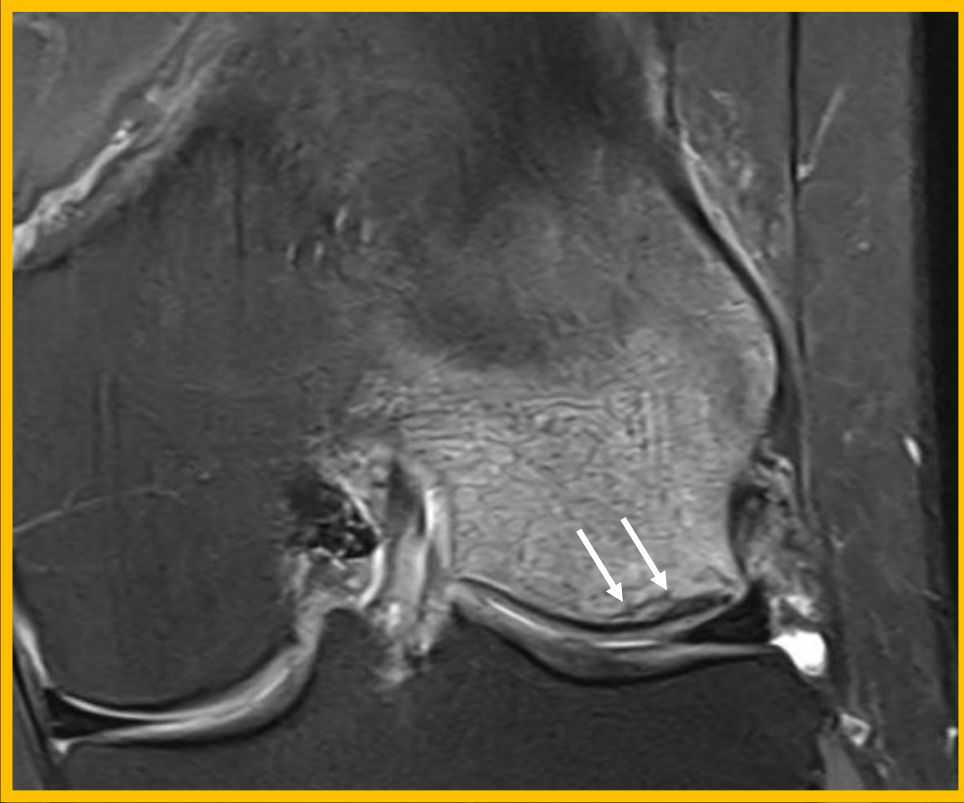
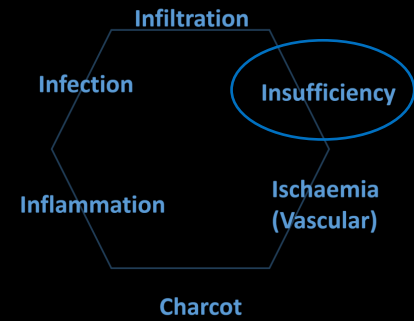
Separate to but subjacent to bone plate

Surrounded by +++ BMO

Subchondral insufficiency Fracture (SIF) versus AVN

LEARNING POINT: SUBCHONDRA INSUFFICIENCY FRACTURE VS AVN

Subchondral insufficiency fracture is thinner and less geographic than AVN

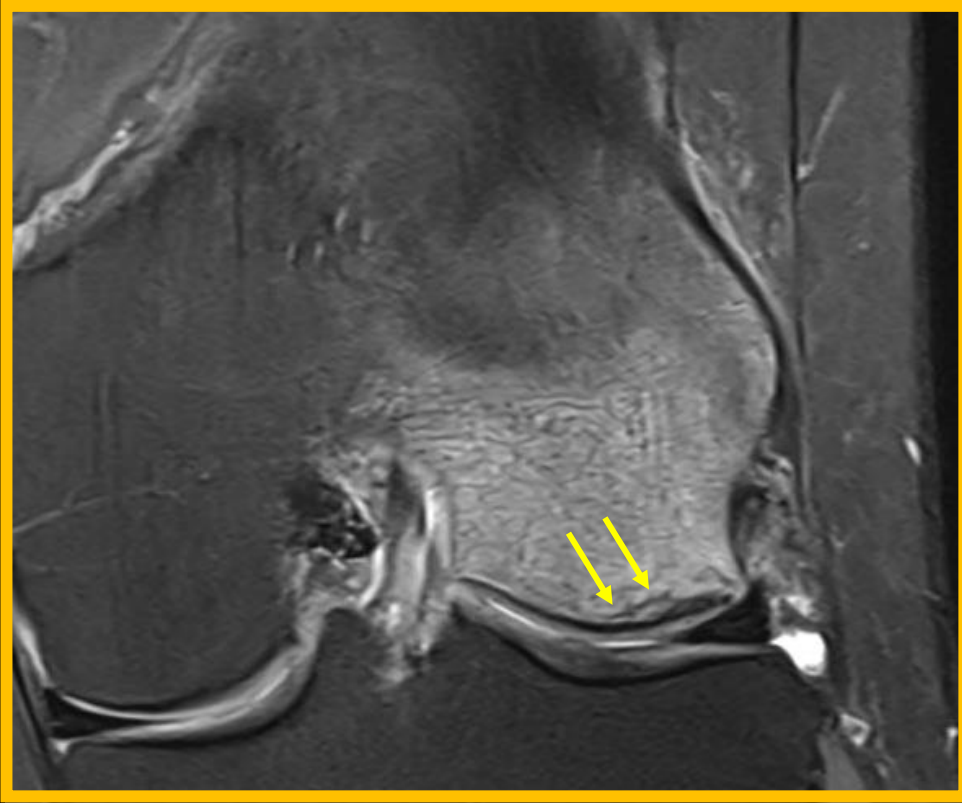
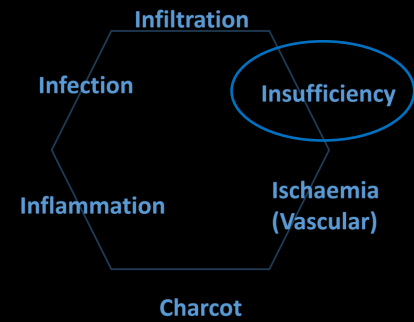


**SUBCHONDRA INSUFFICIENCY
FRACTURE**

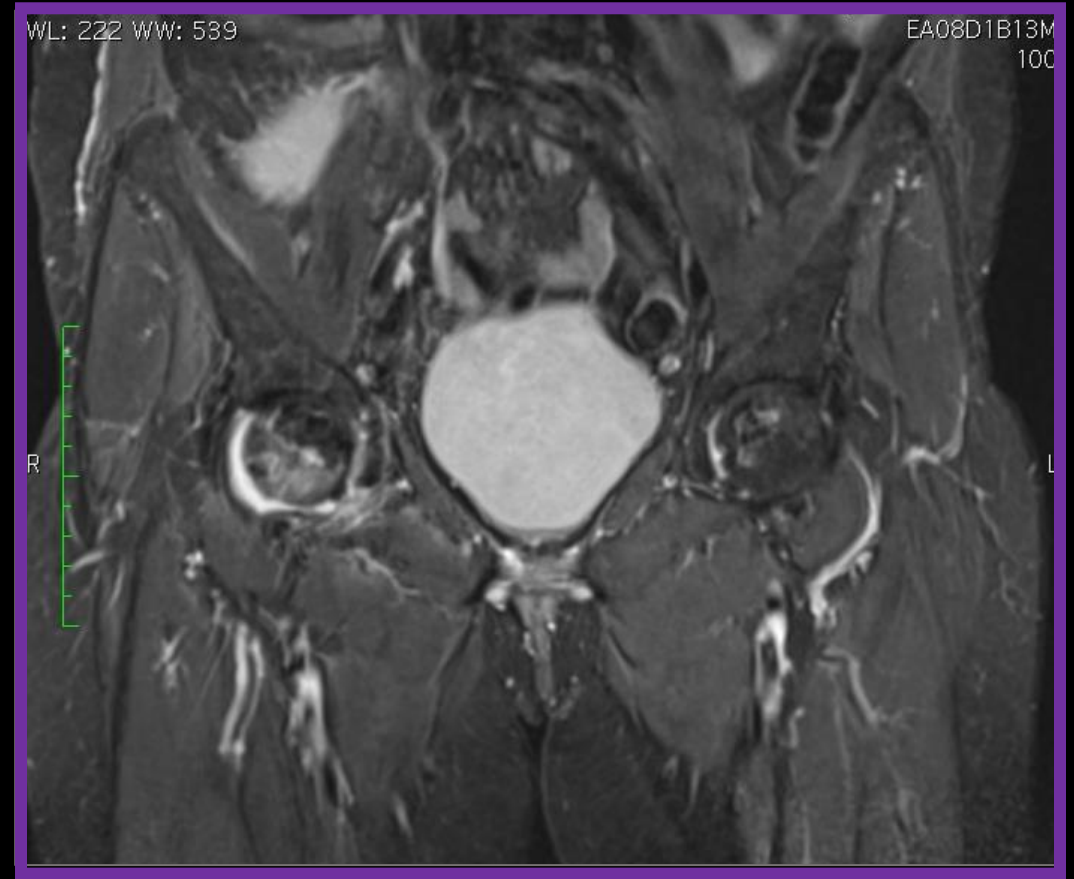
Subchondral insufficiency Fracture (SIF) versus AVN

LEARNING POINT: SUBCHONDRA INSUFFICIENCY FRACTURE VS AVN

Subchondral insufficiency fracture is thinner and less geographic than AVN



**SUBCHONDRA INSUFFICIENCY
FRACTURE**

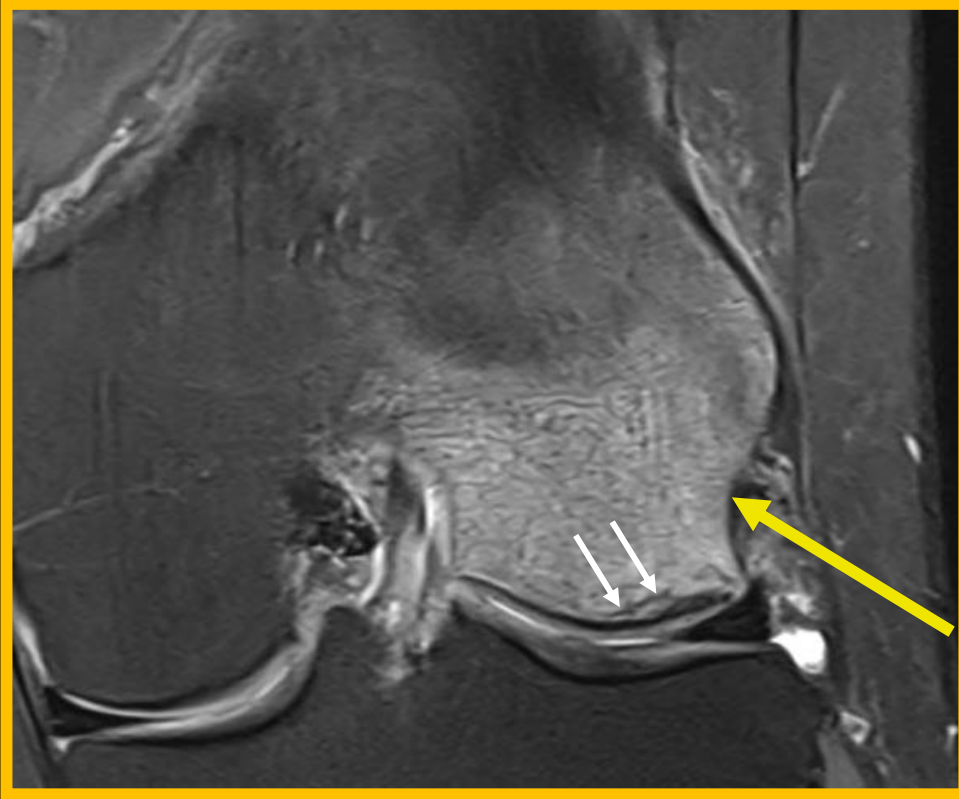
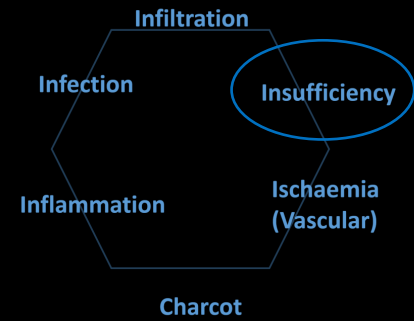


AVASCULAR NECROSIS

Subchondral insufficiency Fracture (SIF) versus AVN

LEARNING POINT: SUBCHONDRAL INSUFFICIENCY FRACTURE VS AVN

Subchondral insufficiency fracture is thinner and less geographic than AVN



**SUBCHONDRAL INSUFFICIENCY
FRACTURE**

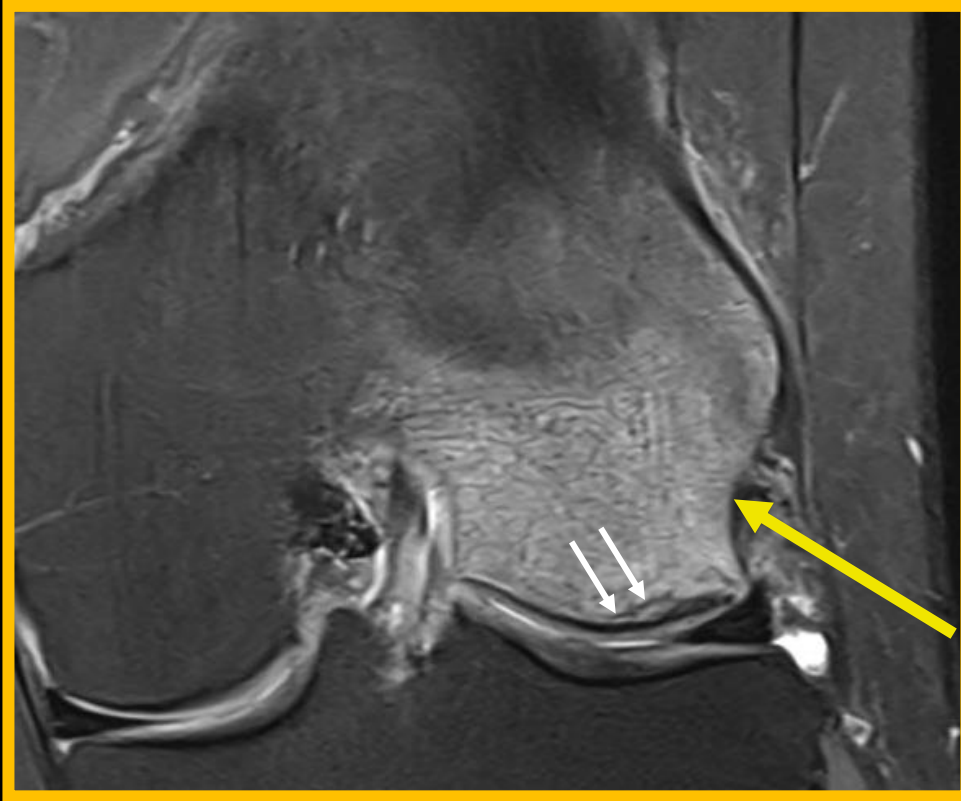
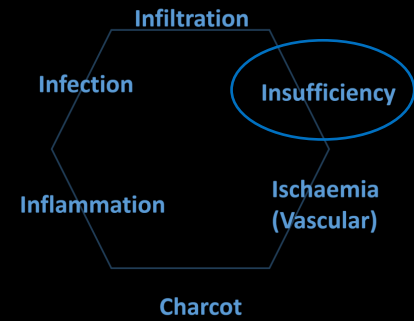


AVASCULAR NECROSIS

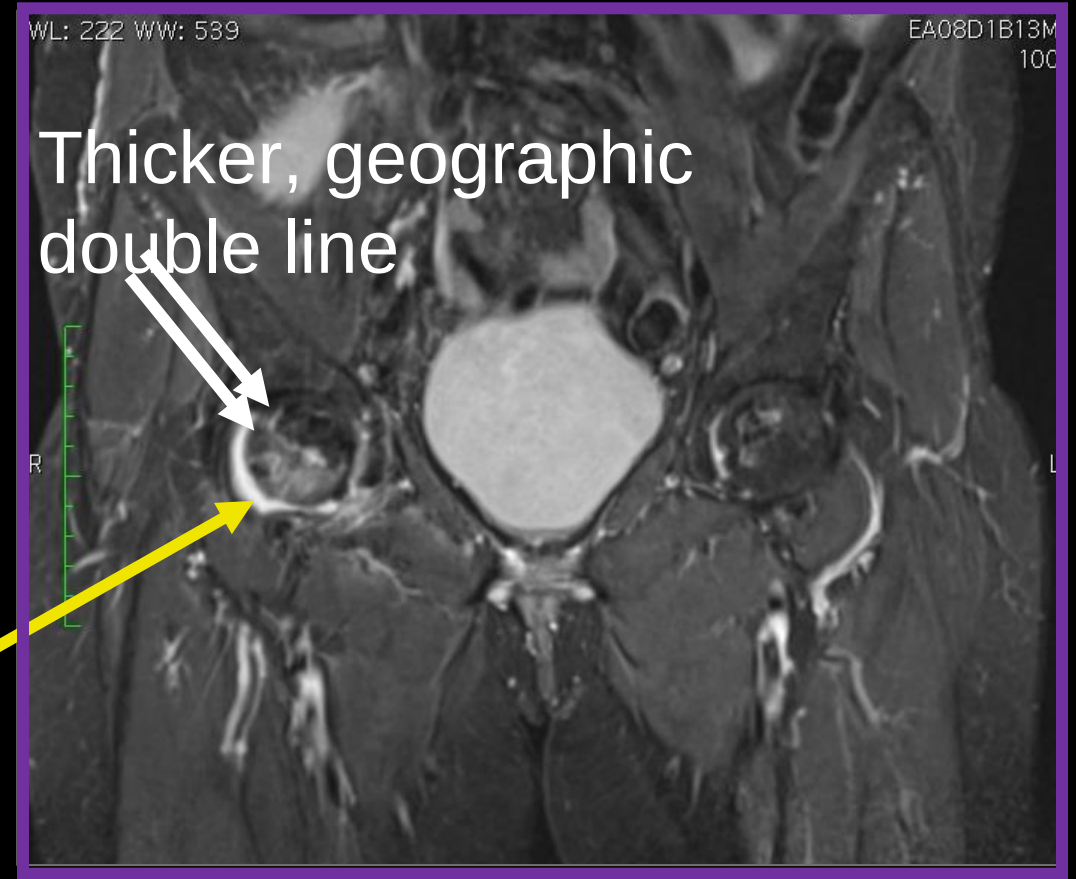
Subchondral insufficiency Fracture (SIF) versus AVN

LEARNING POINT: SUBCHONDRAL INSUFFICIENCY FRACTURE VS AVN

Subchondral insufficiency fracture is thinner and less geographic than AVN



SUBCHONDRAL INSUFFICIENCY FRACTURE



AVASCULAR NECROSIS

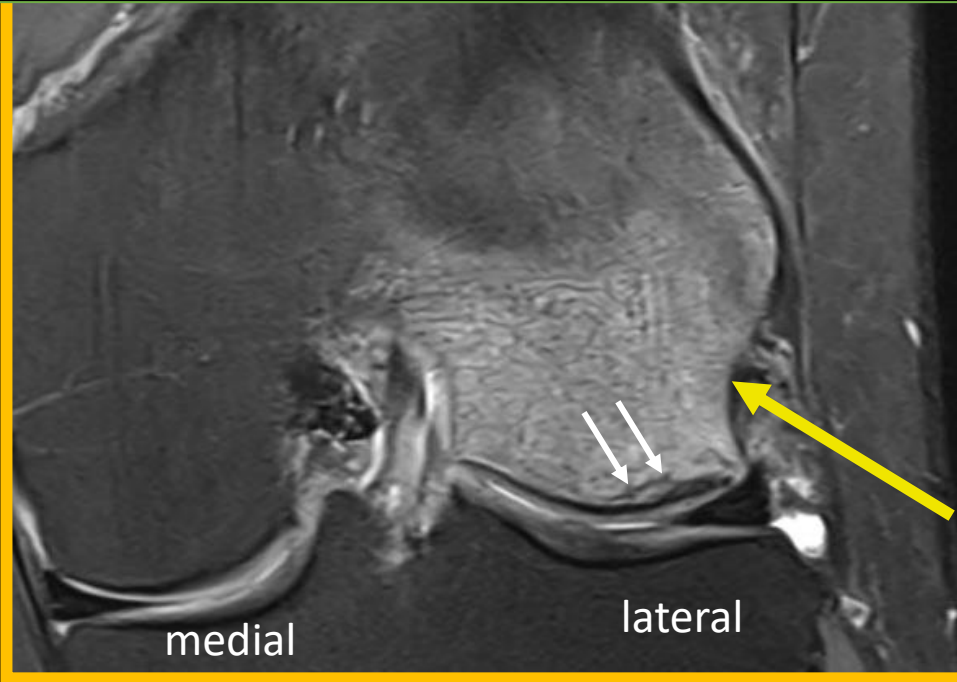
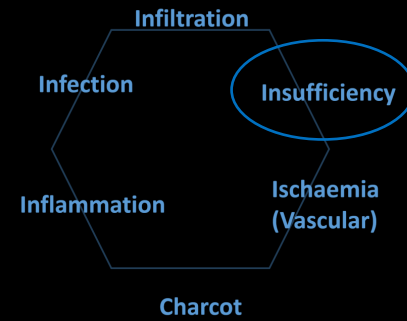
Subchondral insufficiency Fracture (SIF): Progress

LEARNING POINT: SIF - USE FOLLOW UP!

May recover

May be migratory

May progress to AVN & collapse of bone plate



Bone
marrow
oedema

**LATERAL SUBCHONDRAL
INSUFFICIENCY FRACTURE**

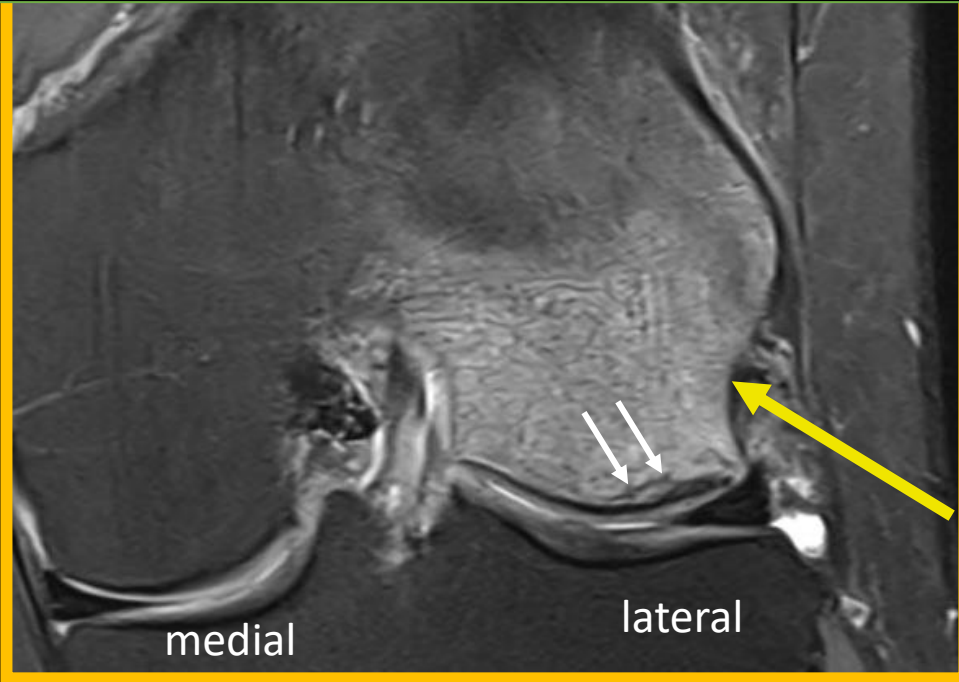
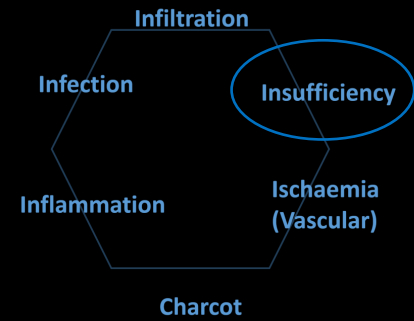
Subchondral insufficiency Fracture (SIF): Progress

LEARNING POINT: SIF - USE FOLLOW UP!

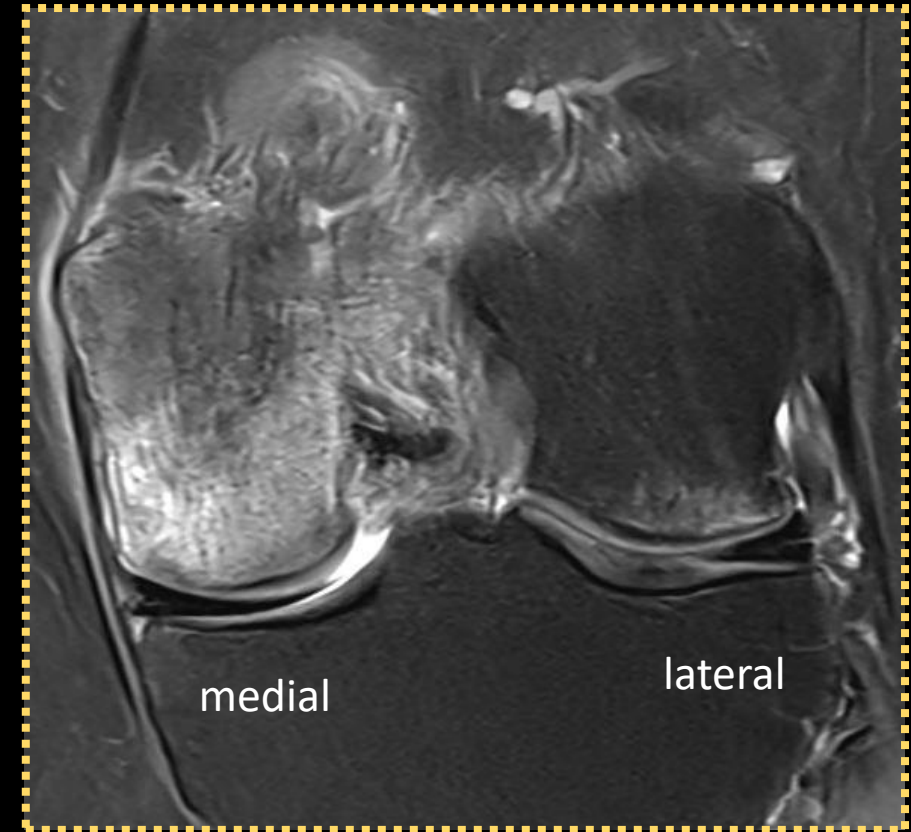
May recover

May be migratory

May progress to AVN & collapse of bone plate

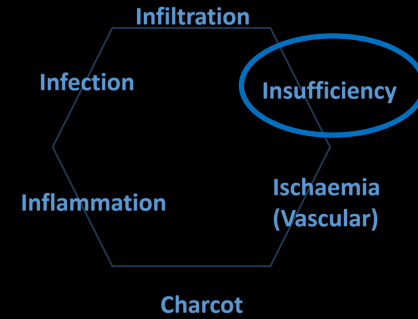
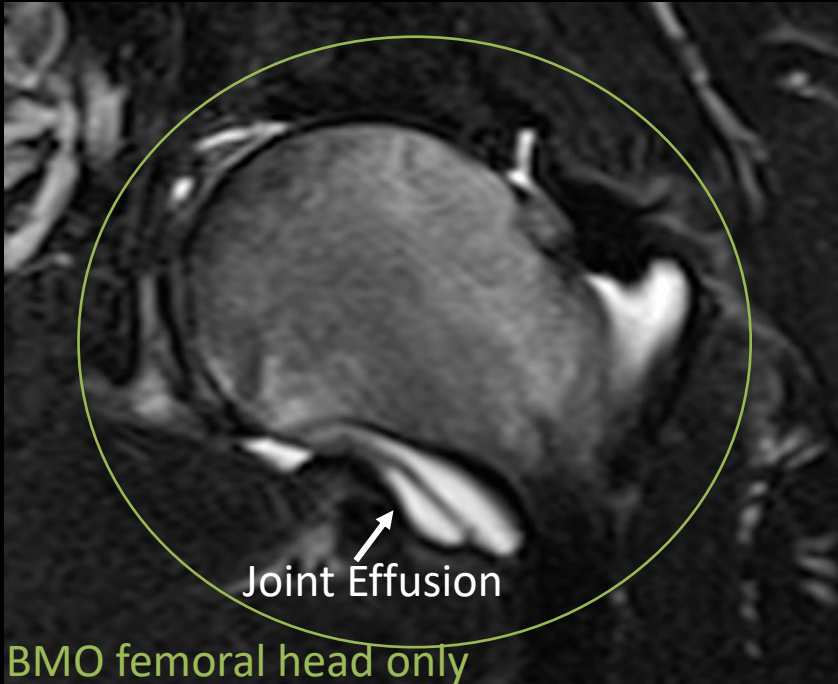


**LATERAL SUBCHONDRAL
INSUFFICIENCY FRACTURE**

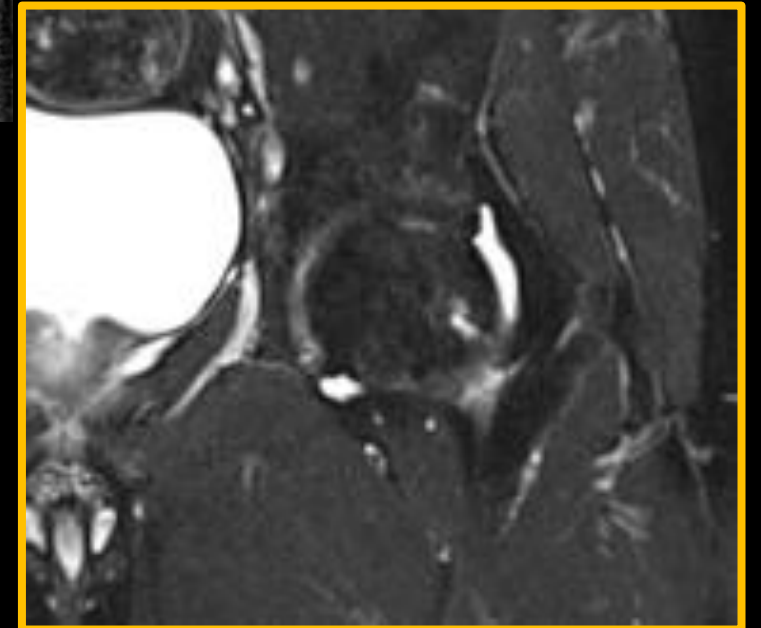


**SAME PATIENT 6 months later
MEDIAL SIF**

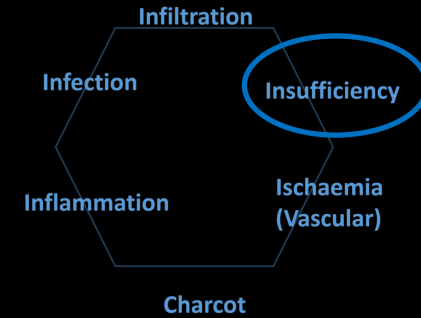
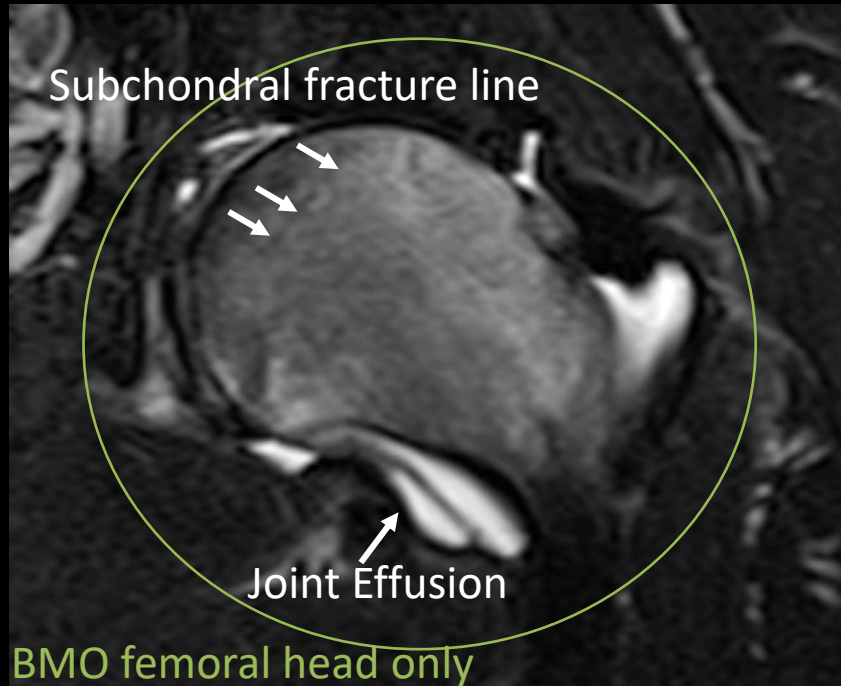
Companion Case: Subchondral Insufficiency



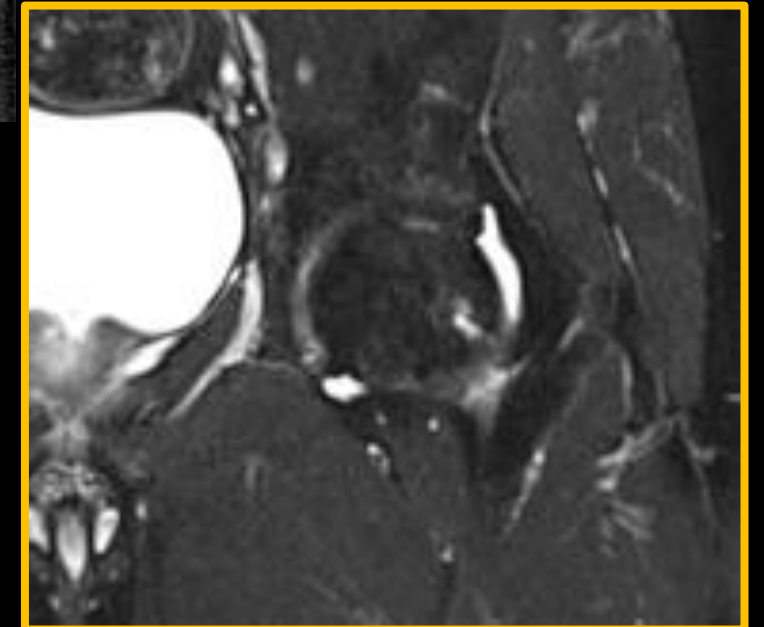
6 months later
resolved



Companion Case: Subchondral Insufficiency



6 months later
resolved



Learning point

Does Transient Osteoporosis = subchondral insufficiency fracture in all cases?

Stress versus Insufficiency fractures

STRESS Fracture

Normal Bone

Abnormal Stress

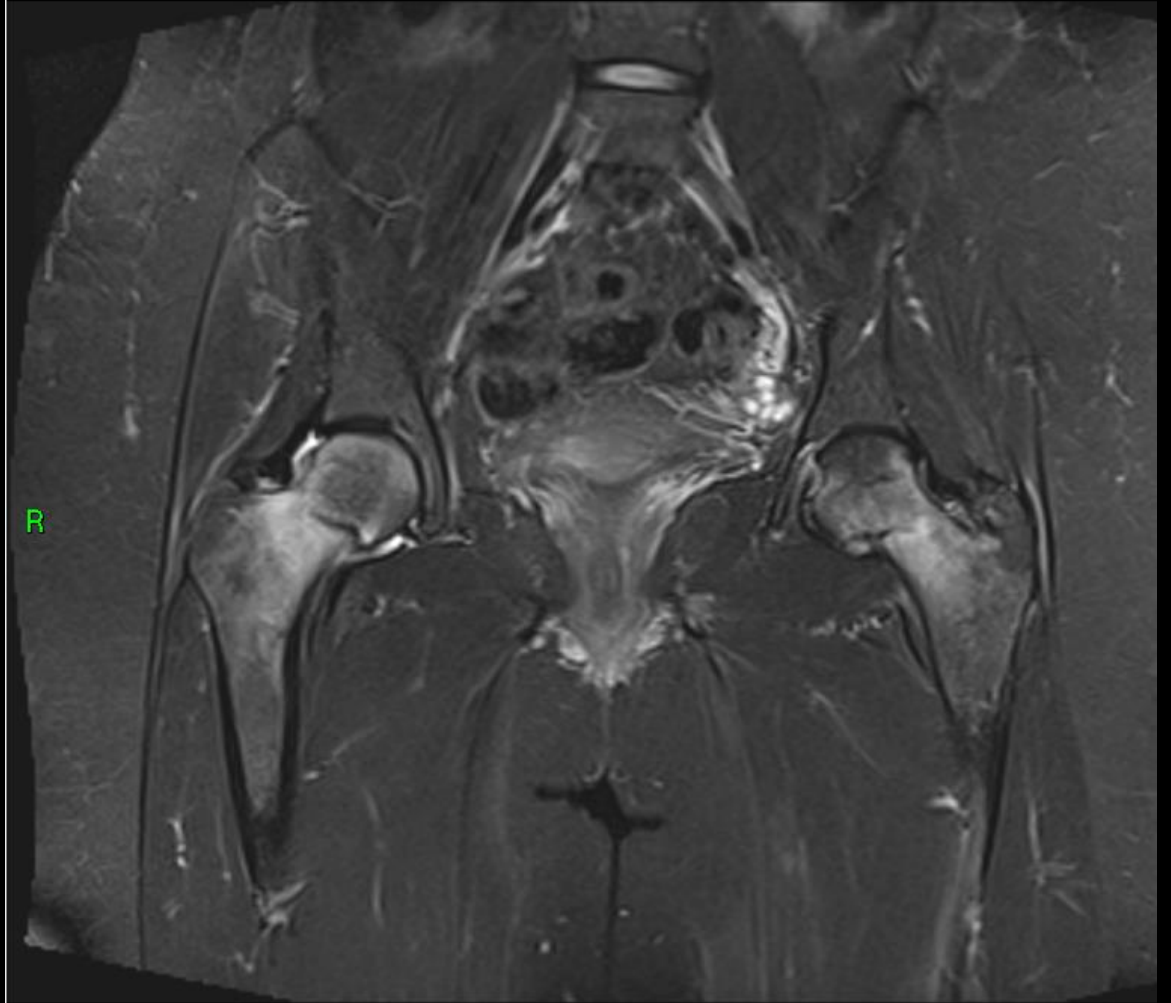
Insufficiency Fracture

Abnormal Bone

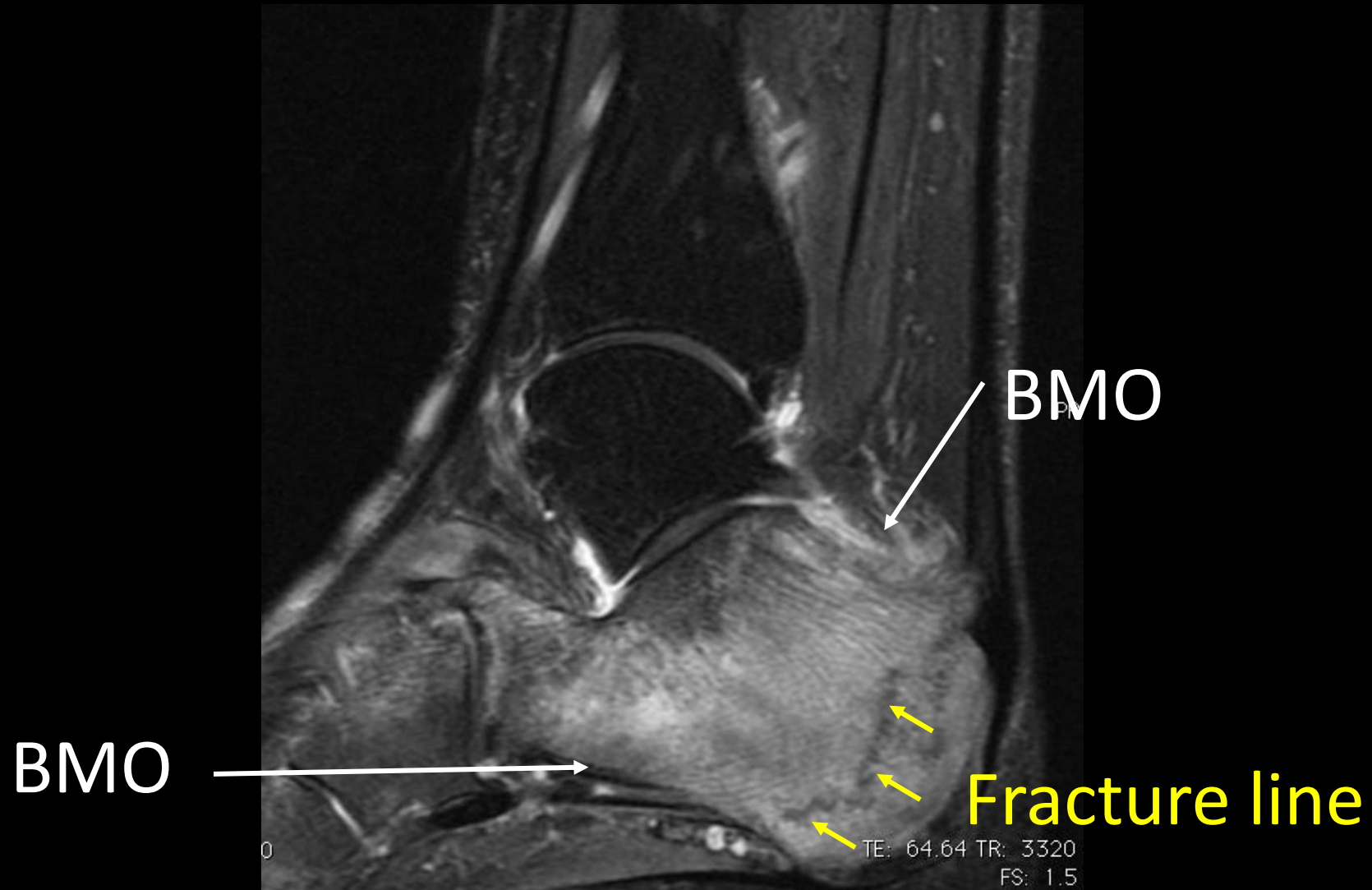
Normal Stress



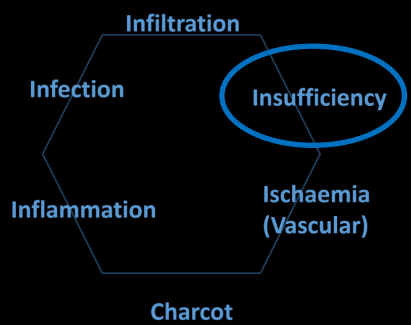
Companion Case: Bilateral Femoral Neck insufficiency fractures in Osteomalacia



Keen runner Heel pain



Keen runner Heel pain Dx: Stress/insufficiency fracture of calcaneum



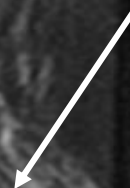
Learning point

In athletes, 'low energy availability' increases risk of fractures

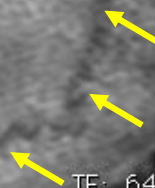
BMO



BMO



Fracture line

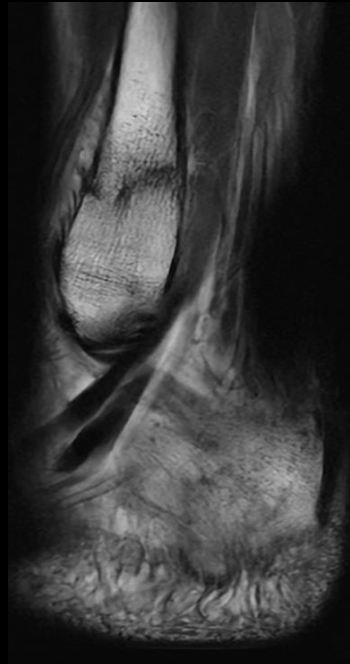


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FS: 1.5

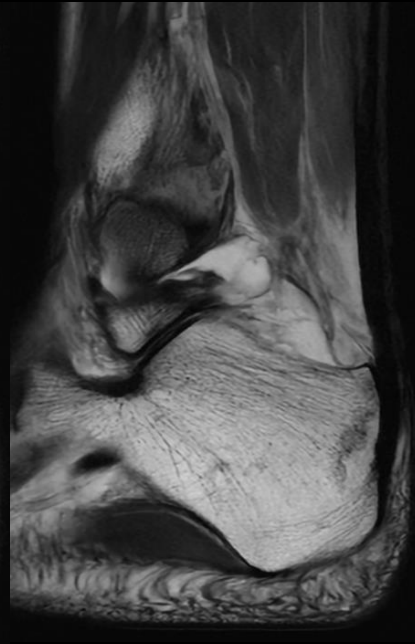
Anorexia, Lateral ankle and Heel Pain



Cor PD
fat sat



Sag T2
fat sat

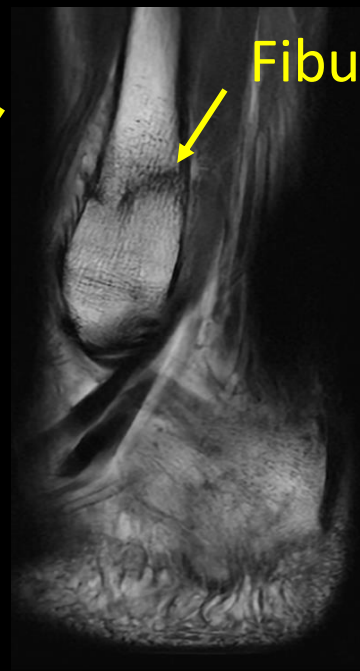


T2 fat sat

Anorexia, Lateral ankle and Heel Pain



Cor PD
fat sat



Sag T2
fat sat



T2 fat sat

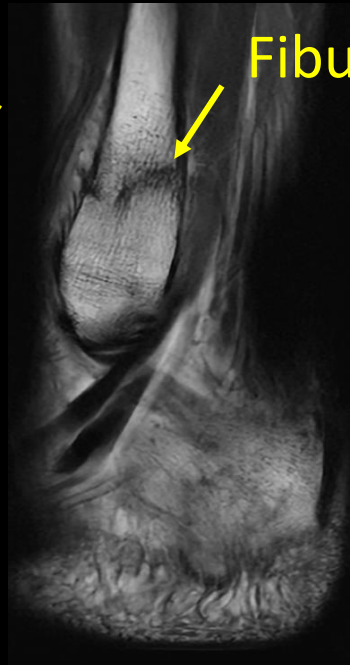
Fibula insufficiency #

Calcaneal
insufficiency #

Anorexia, Lateral ankle and Heel Pain



Cor PD
fat sat



Sag T2
fat sat



T2 fat sat

Fibula insufficiency #

Calcaneal
insufficiency #

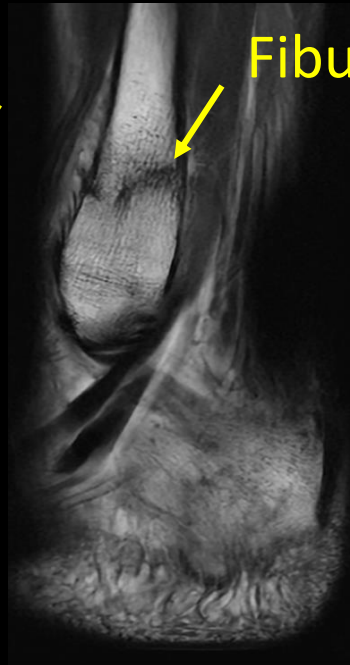


Fat Saturation
doesn't seem
to be working?

Anorexia, Lateral ankle and Heel Pain



Cor PD
fat sat



Sag T2
fat sat



T2 fat sat

Fibula insufficiency #

Calcaneal
insufficiency #



T2 fat sat



T1

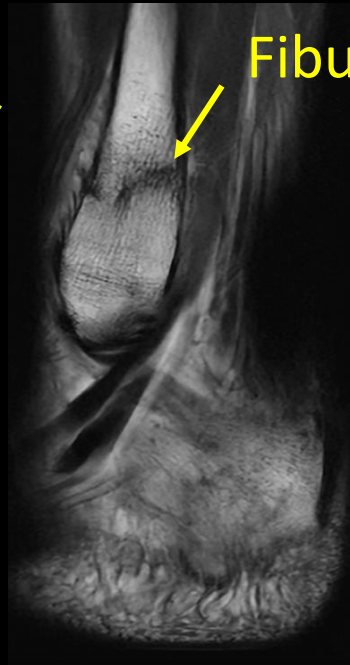


Fat Saturation
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Anorexia, Lateral ankle and Heel Pain



Cor PD
fat sat



Sag T2
fat sat



T2 fat sat

Calcaneal
insufficiency #



T2 fat sat



T1



STIR

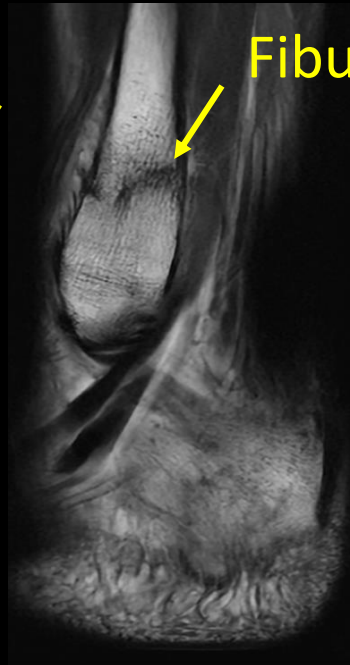


Fat Saturation
doesn't seem
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Anorexia, Lateral ankle and Heel Pain



Cor PD
fat sat



Sag T2
fat sat



T2 fat sat

Fibula insufficiency #

Calcaneal
insufficiency #



T2 fat sat



T1



STIR

Fat Saturation
doesn't seem
to be working?

SEROUS ATROPHY of
BONE MARROW



Anorexia, Lateral ankle and Heel Pain

Fibula insufficiency #

T2 fat sat

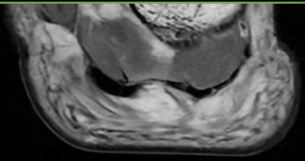
T1

LEARNING POINT:

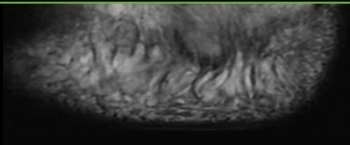
SEROUS ATROPHY of BONE MARROW

Occurs in low body weight

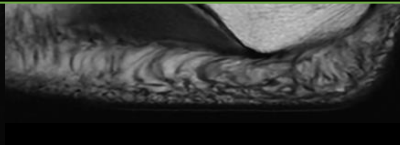
Bone marrow & subcutaneous fat HIGH signal T1 and T2 fat sat



Cor PD
fat sat



Sag T2
fat sat



T2 fat sat

Calcaneal
insufficiency #

STIR



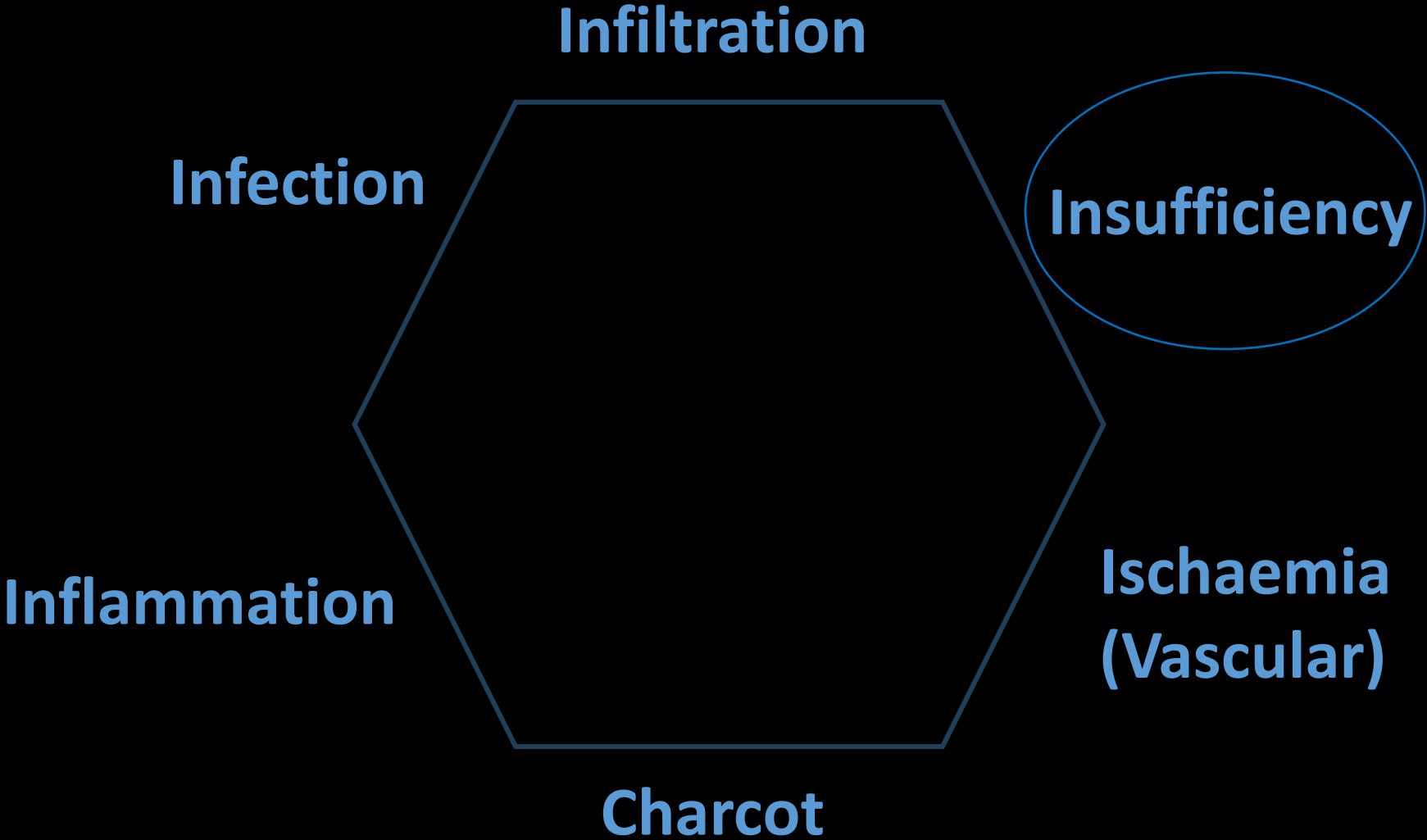
Fat Saturation
doesn't seem
to be working?

SEROUS ATROPHY of
BONE MARROW



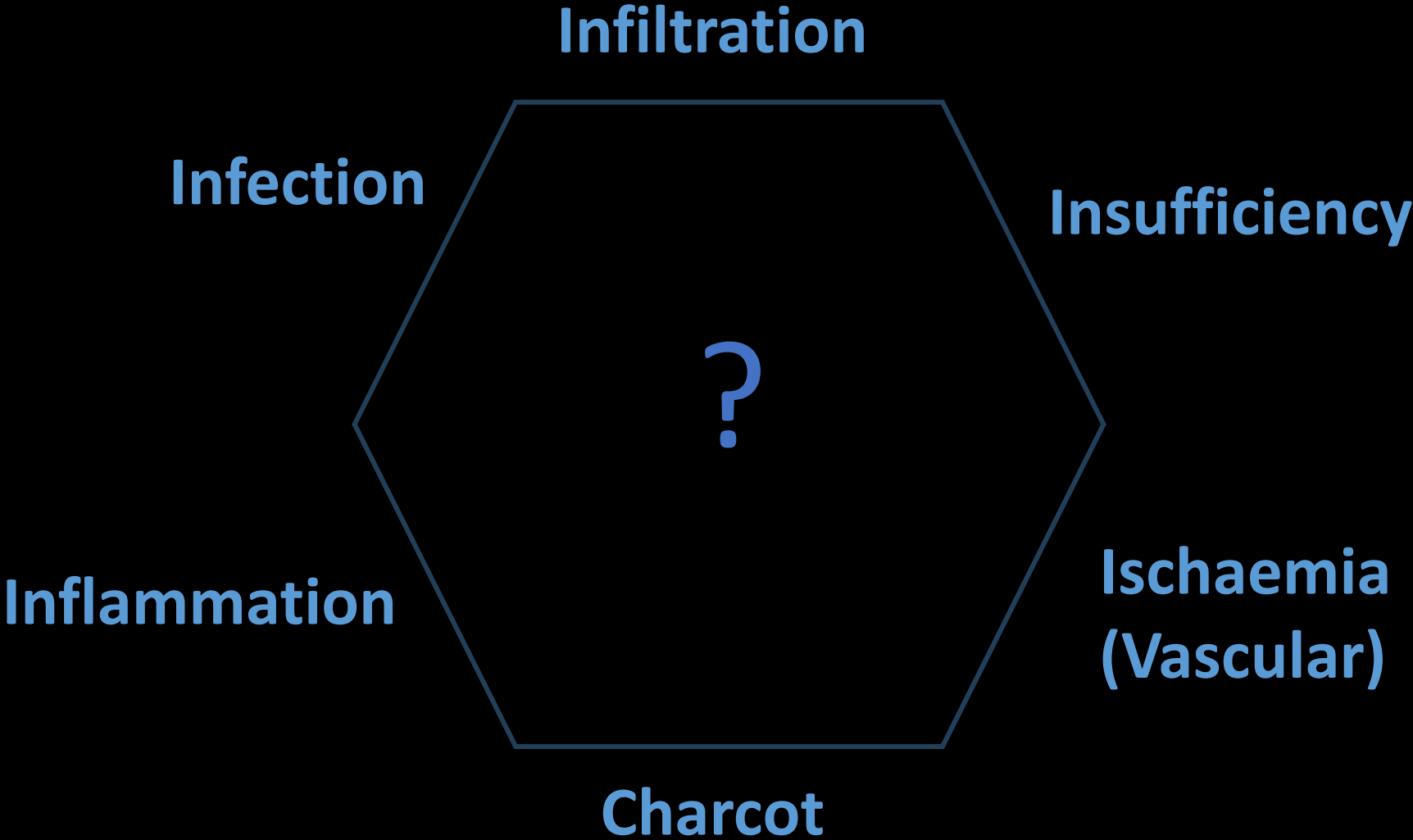


Causes of Bone Marrow Oedema (BMO)



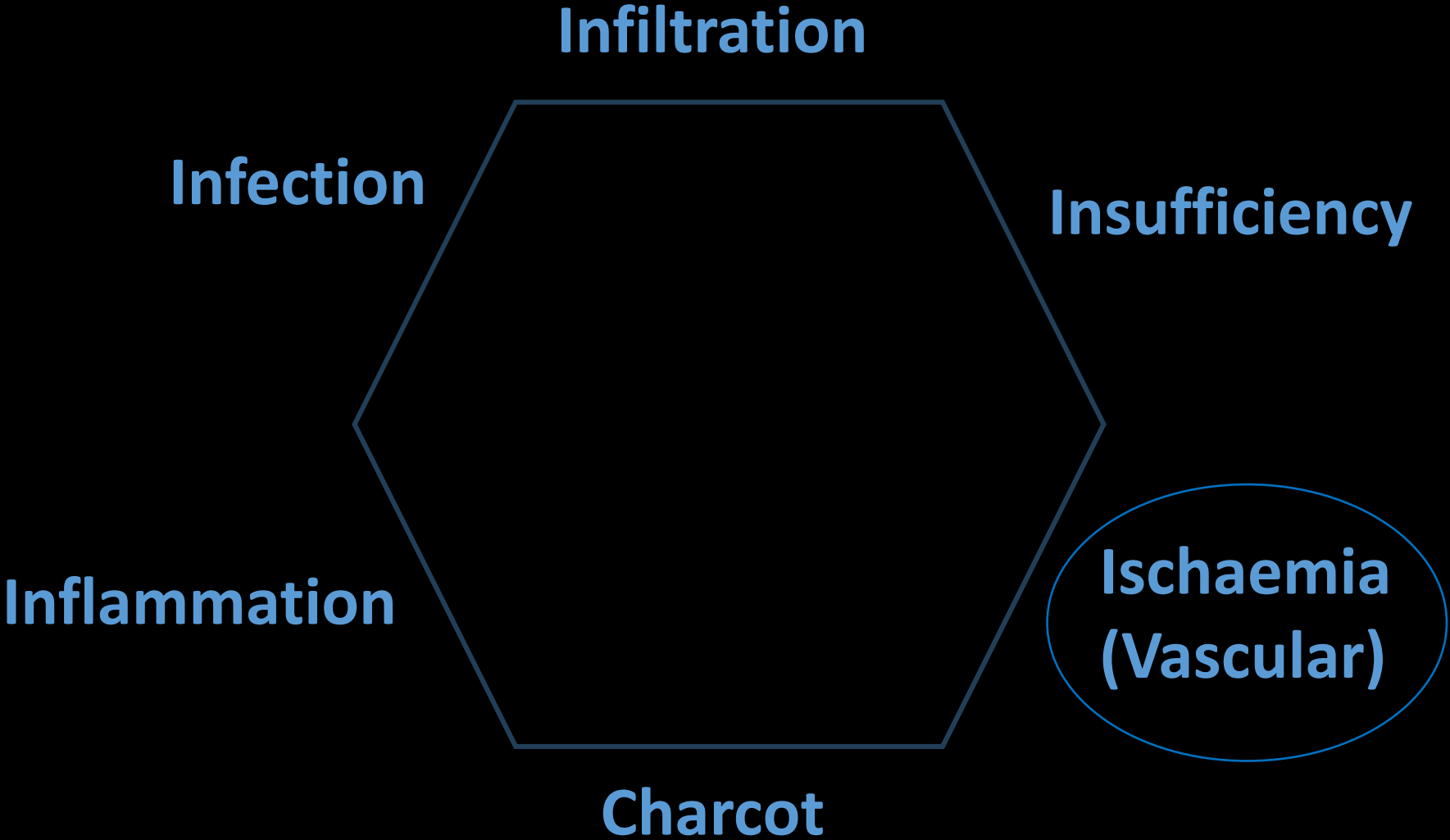


Causes of Bone Marrow Oedema (BMO)

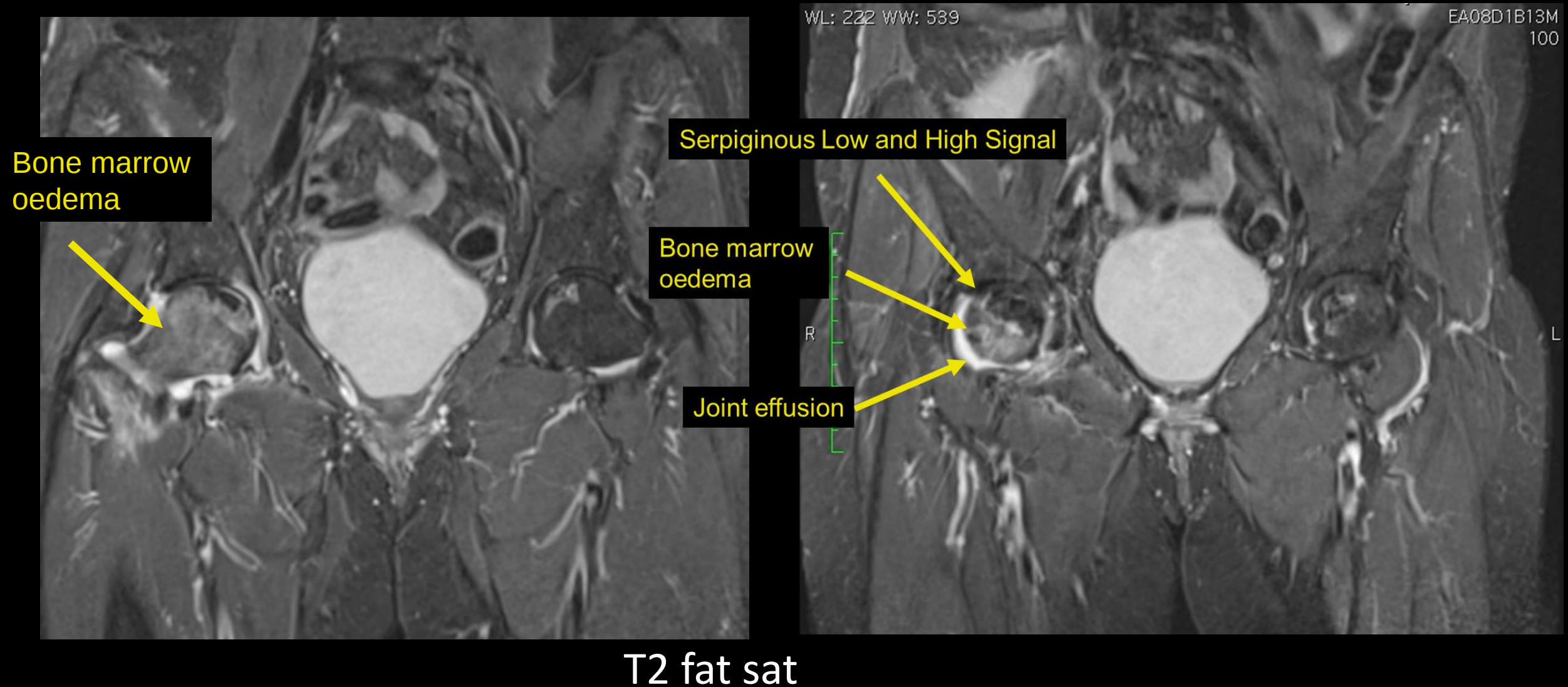




Causes of Bone Marrow Oedema (BMO)



R hip pain Renal Failure, acute AVN R hip



Child with Sickle Cell Disease and acute R leg pain

- Infection, Infarction or both?

Child with Sickle Cell disease and acute leg pain

Choose the correct answers

- A. Periosteal fluid occurs in both osteomyelitis and infarction
- B. Osteomyelitis and infarction can co-exist
- C. Cloaca/cortical breach is a specific sign of infection

Child with Sickle Cell disease and acute leg pain Choose correct answers

Periosteal fluid occurs in both osteomyelitis and infarction

0%

Osteomyelitis and infarction can co-exist

0%

cloaca/cortical breach is a specific sign of infection

0%

Child with Sickle Cell disease and acute leg pain

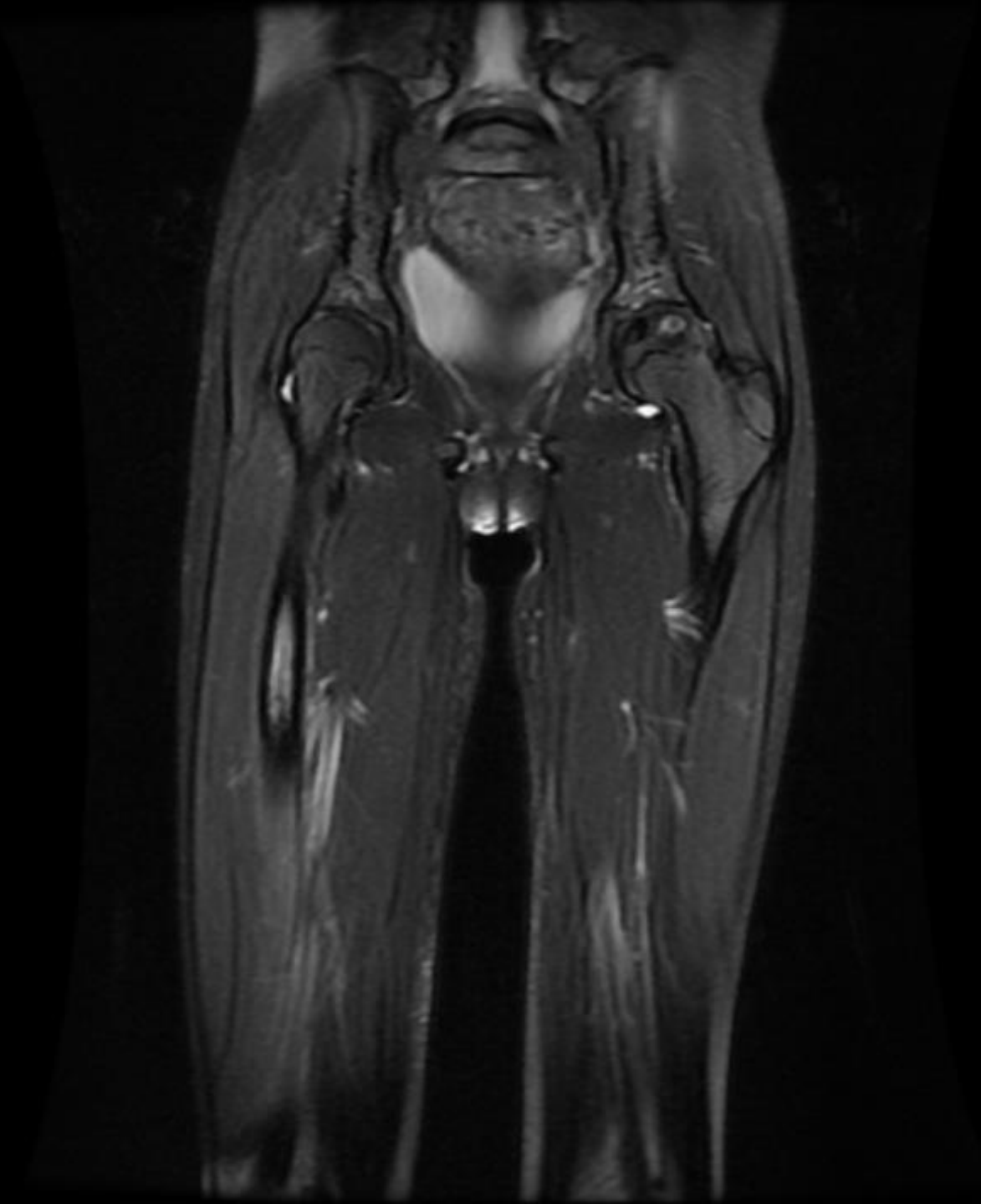
Choose the correct answers

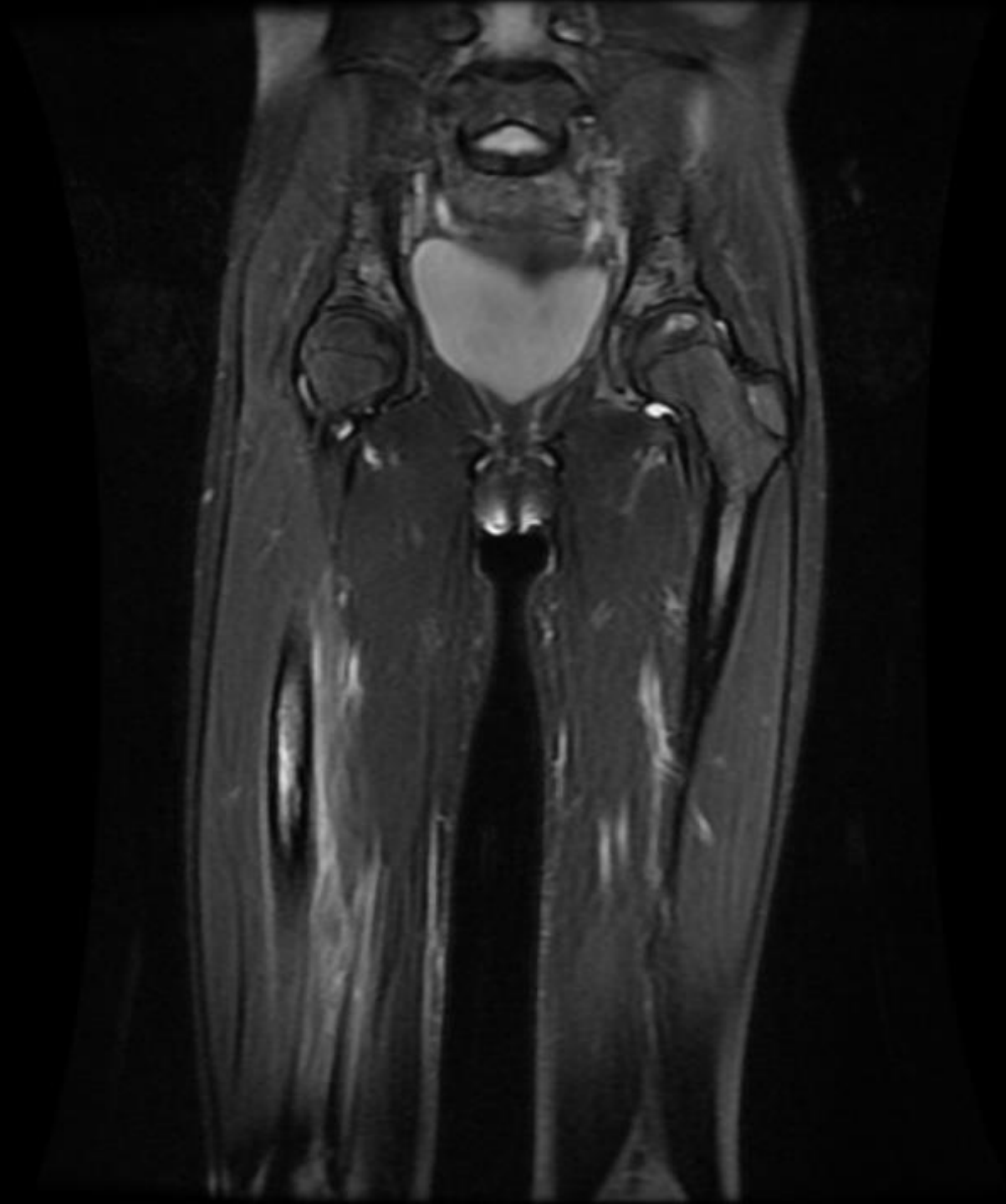
- A. Periosteal fluid occurs in both osteomyelitis and infarction
- B. Osteomyelitis and infarction can co-exist
- C. Cloaca/cortical breach is a specific sign of infection

ALL CORRECT!

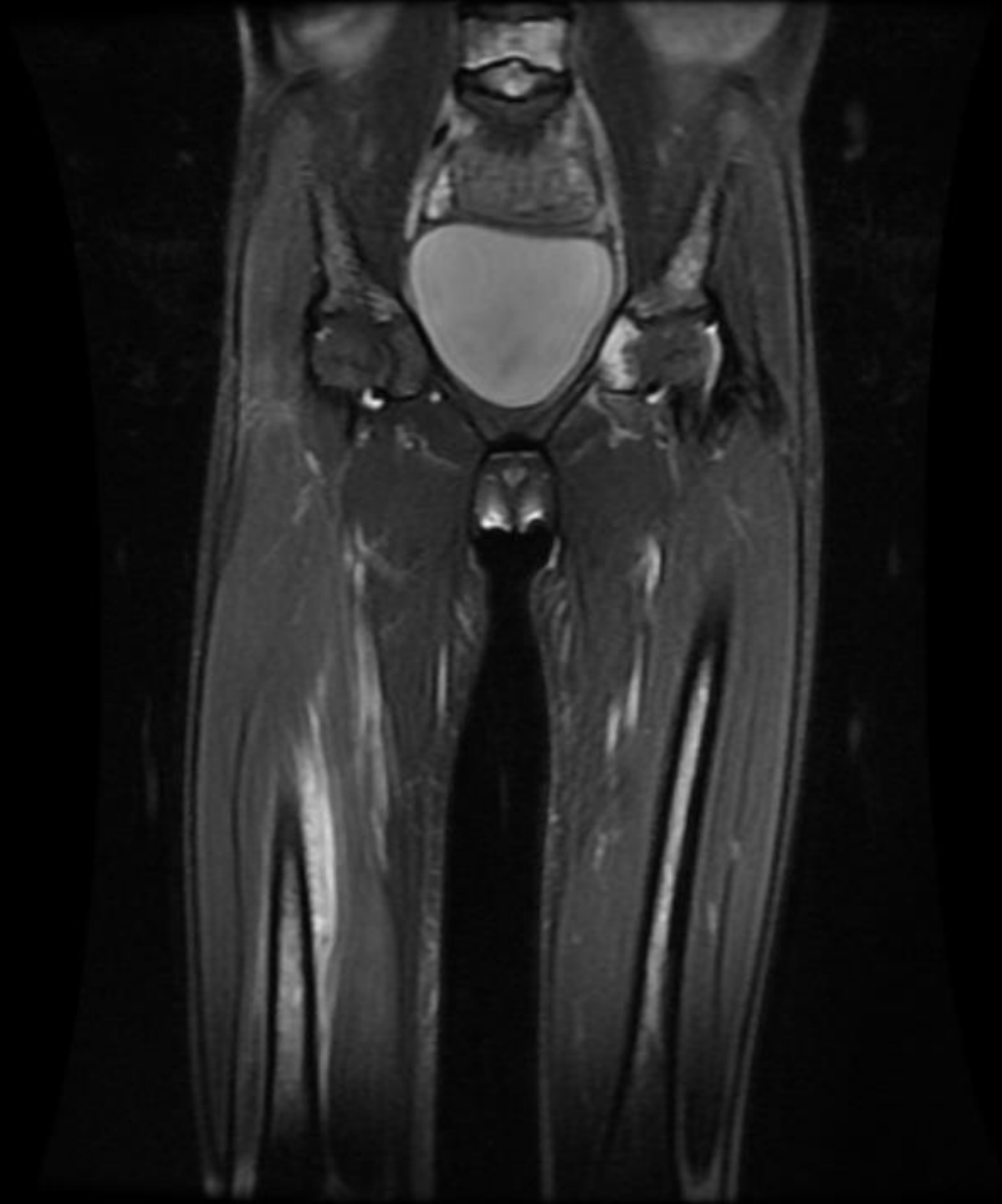
Cor T2 Fat Sat







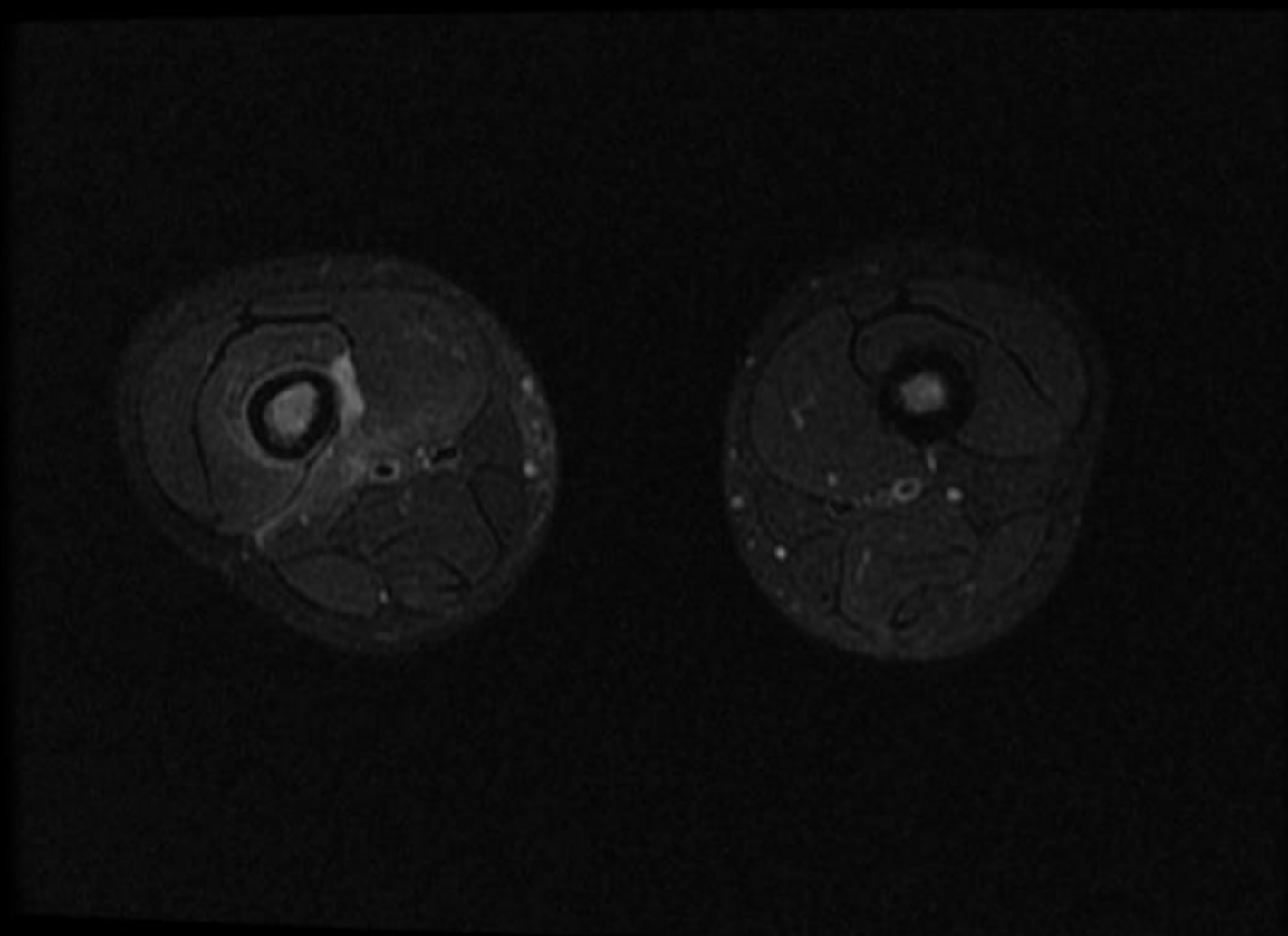


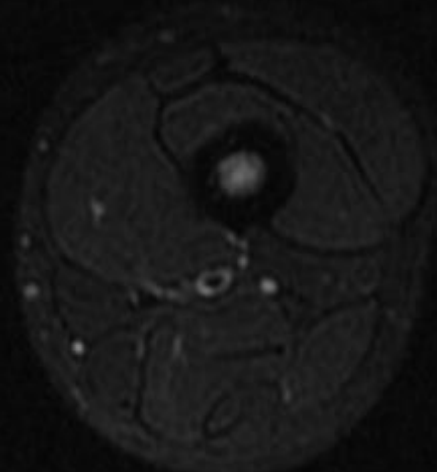
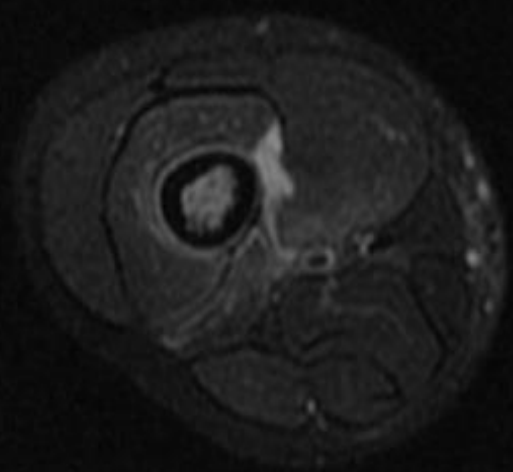


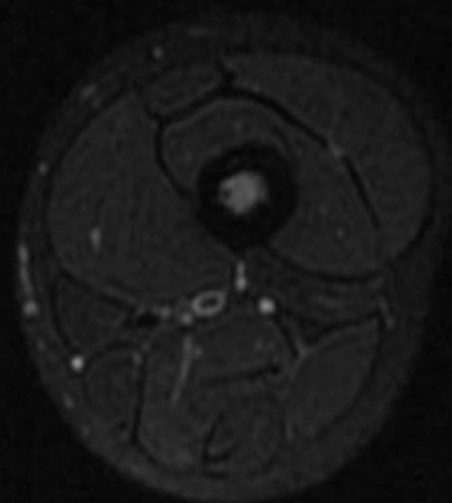
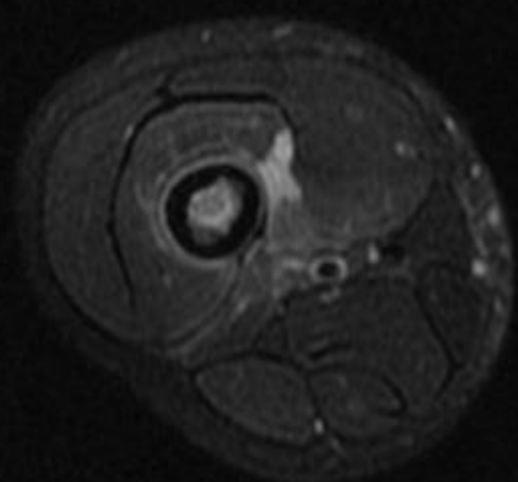


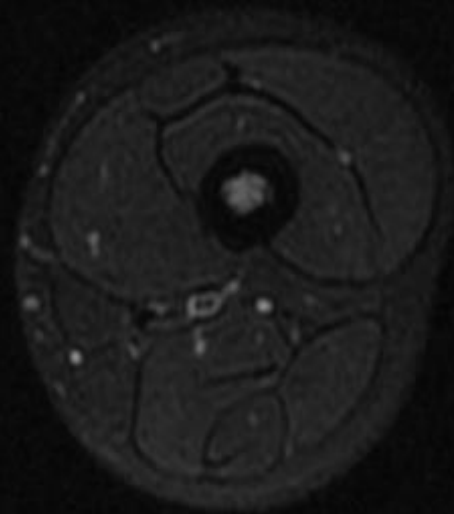
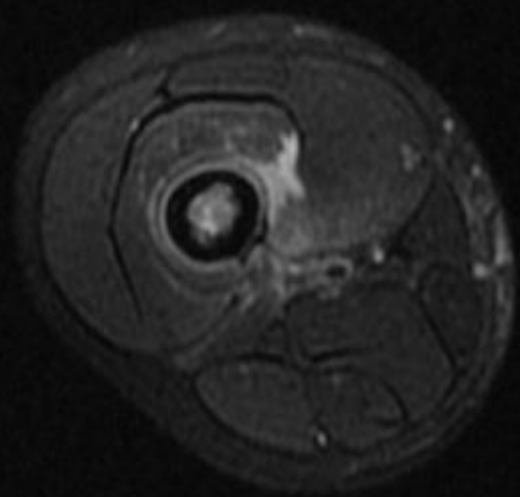


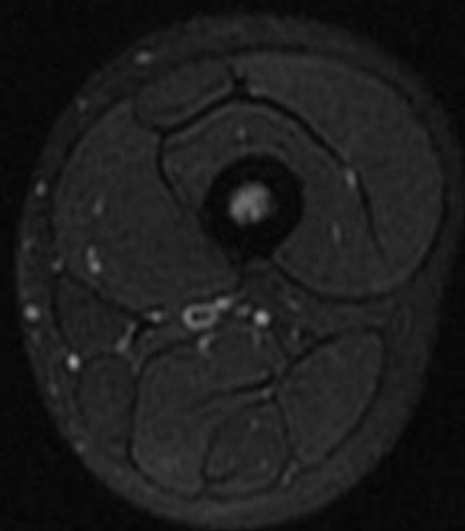
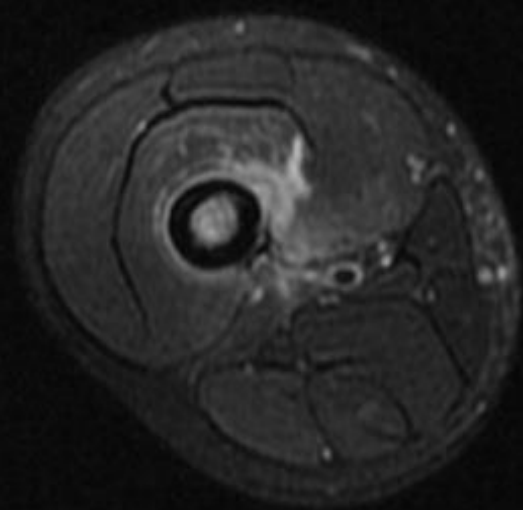
Ax T2 fat sat

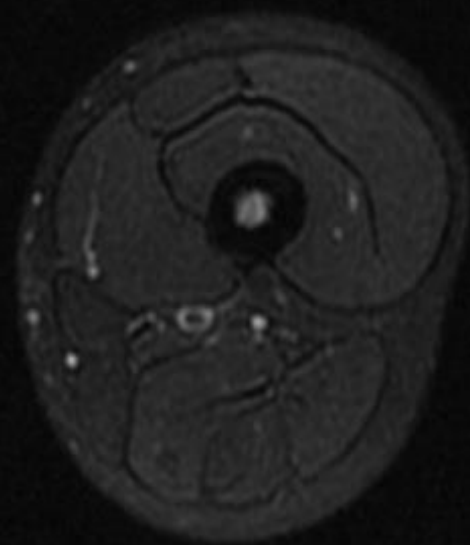
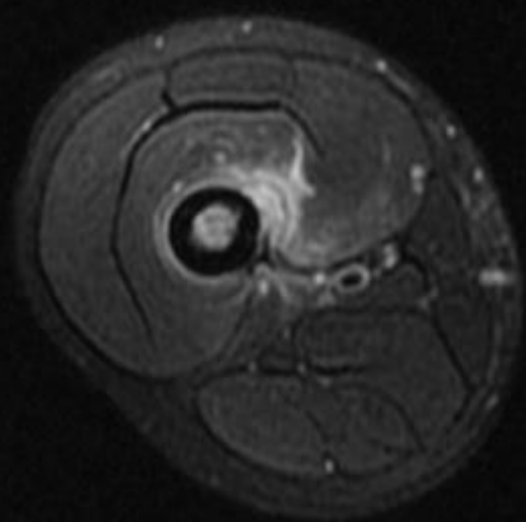


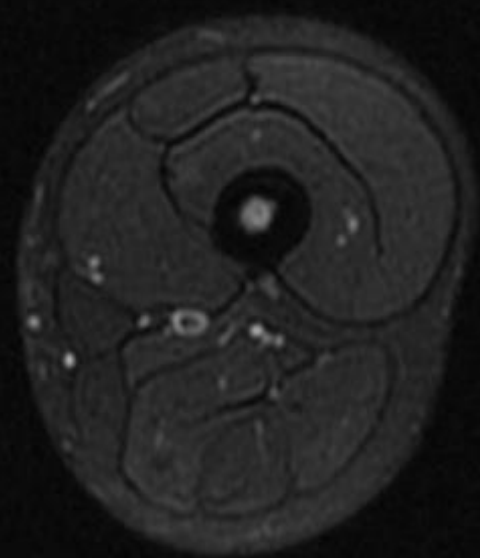
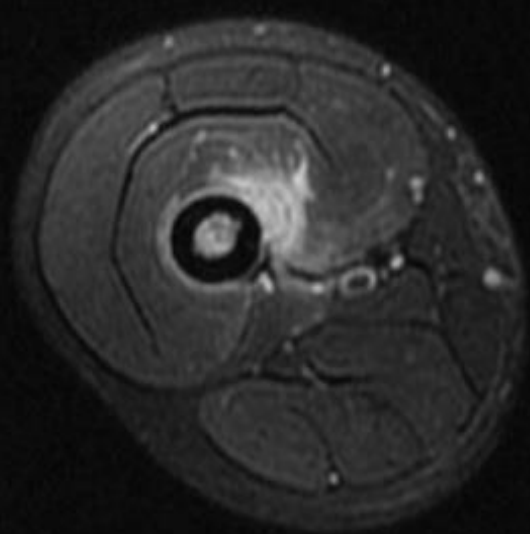


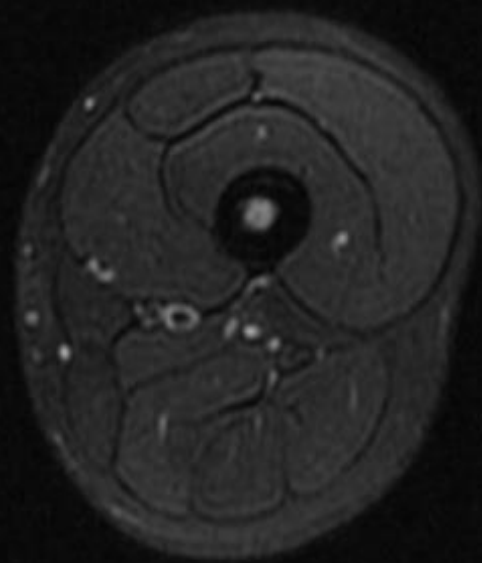
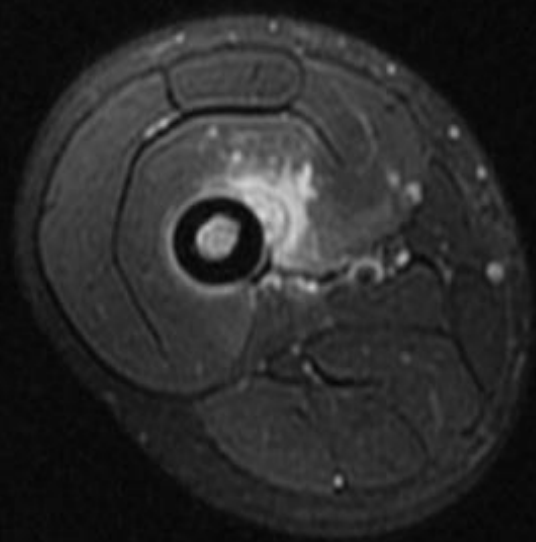


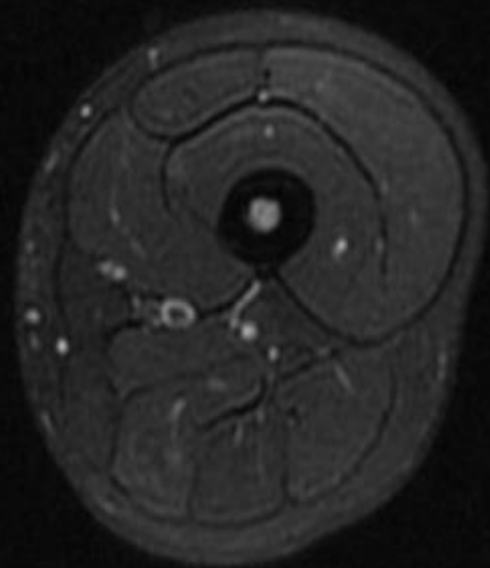
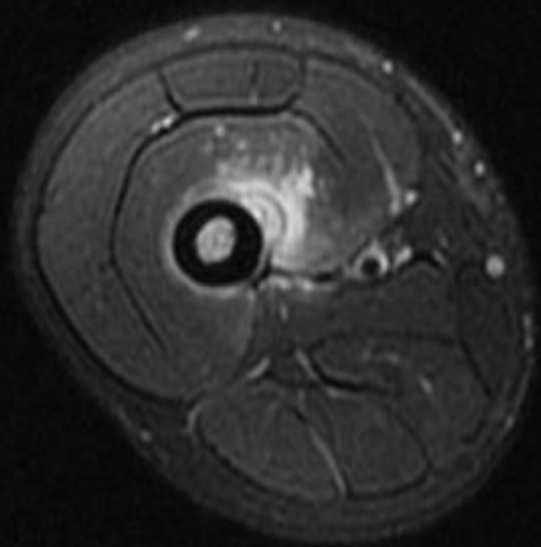


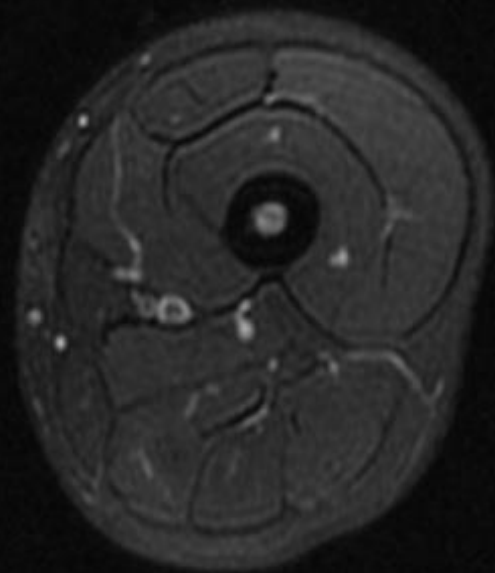
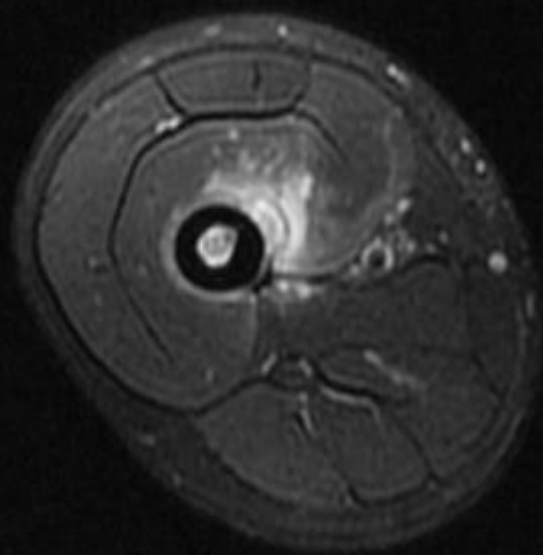


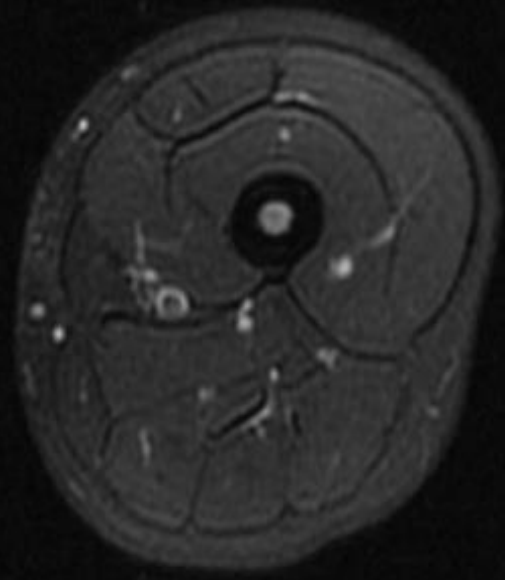
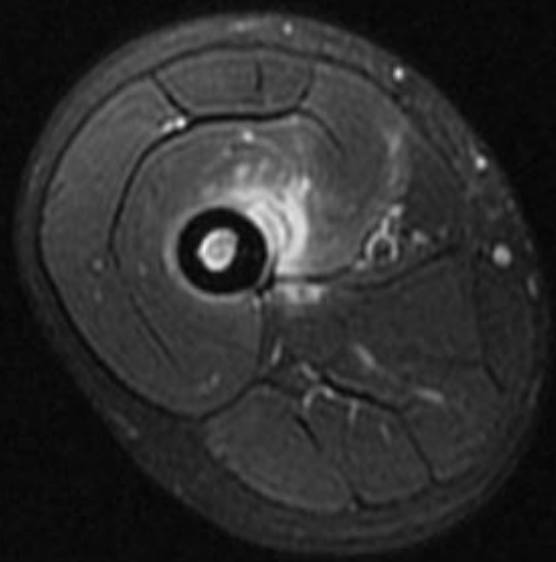


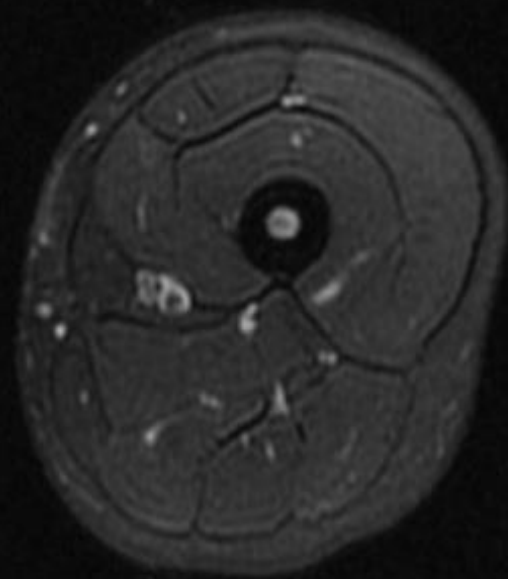
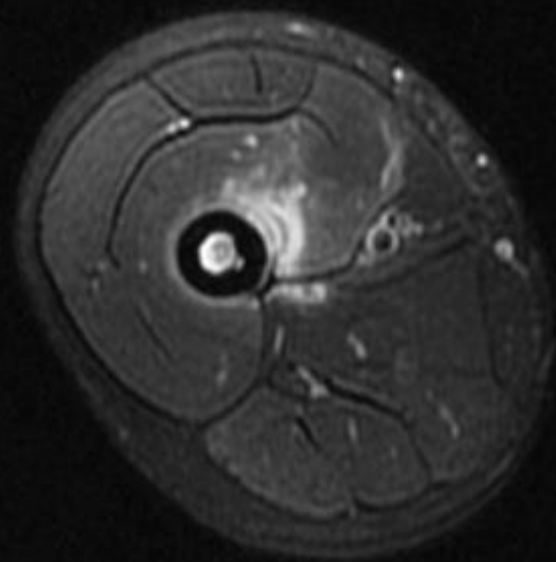


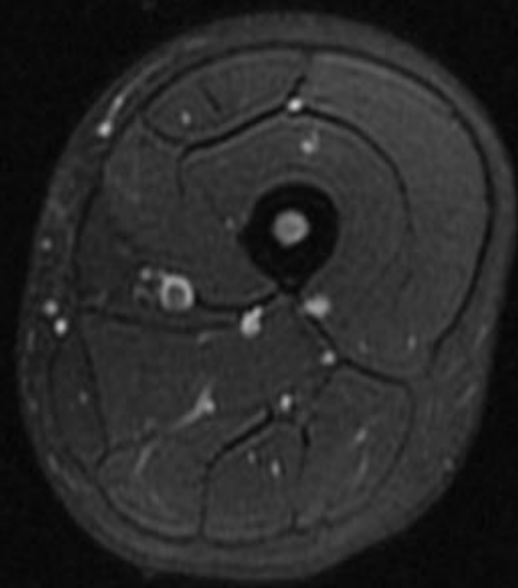
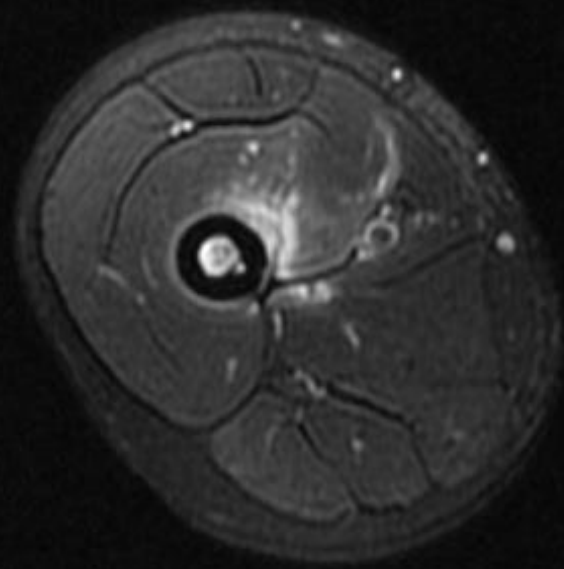


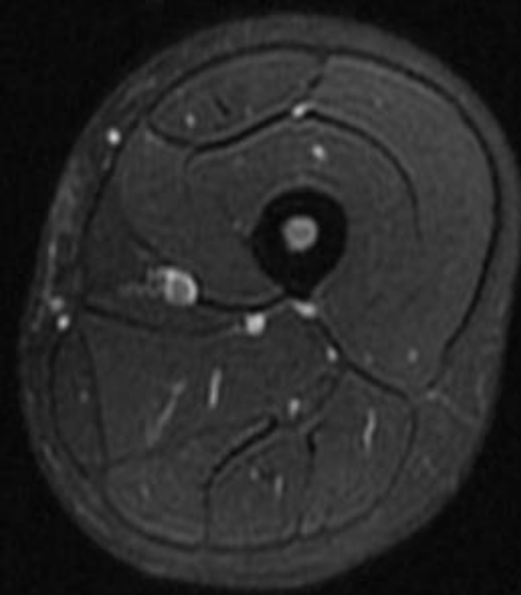
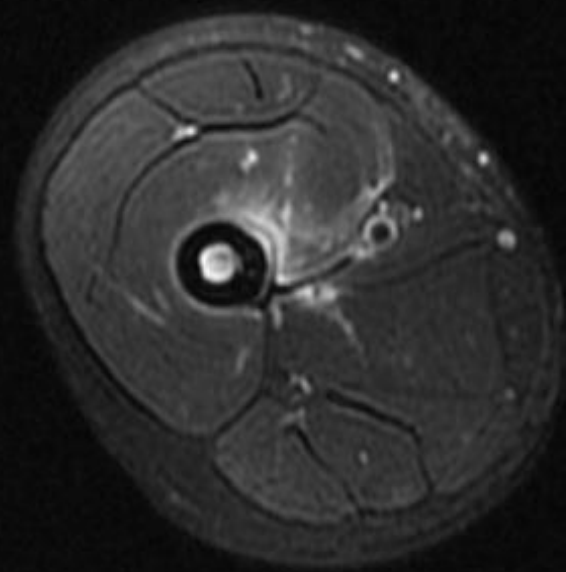


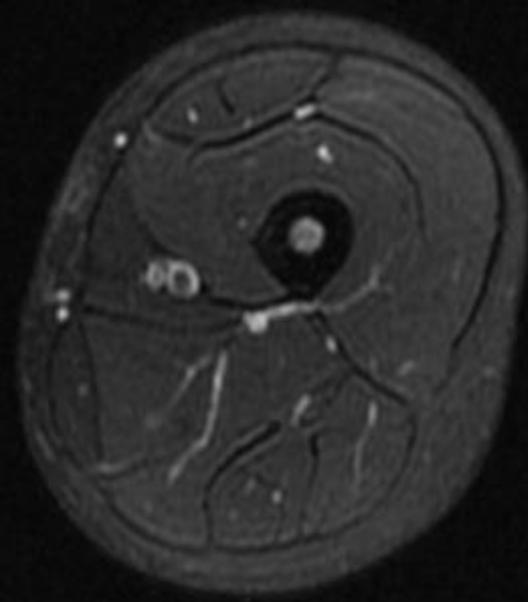
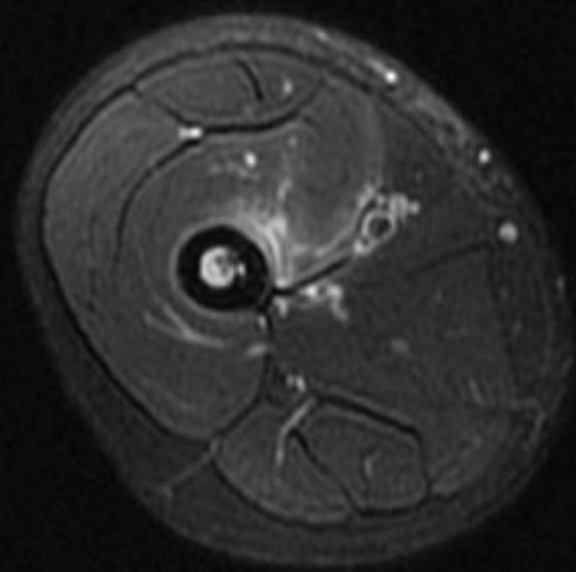


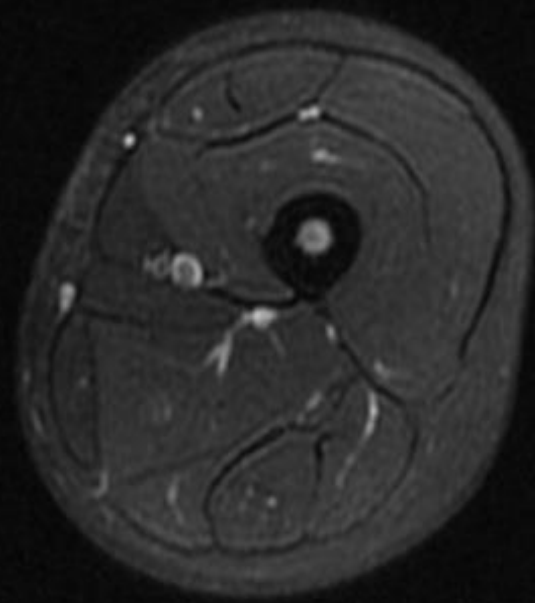
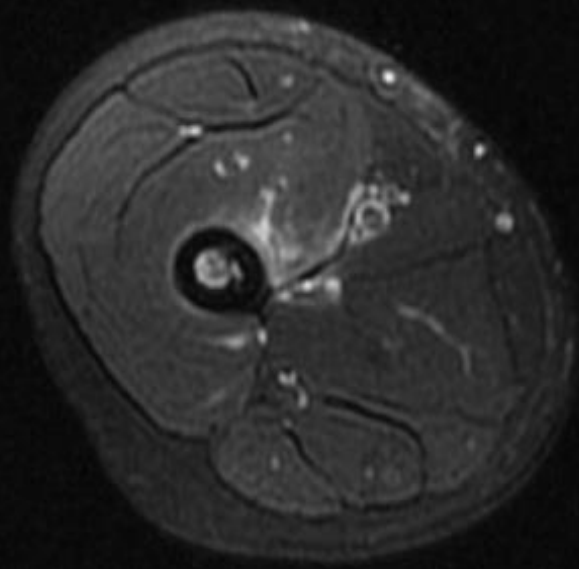


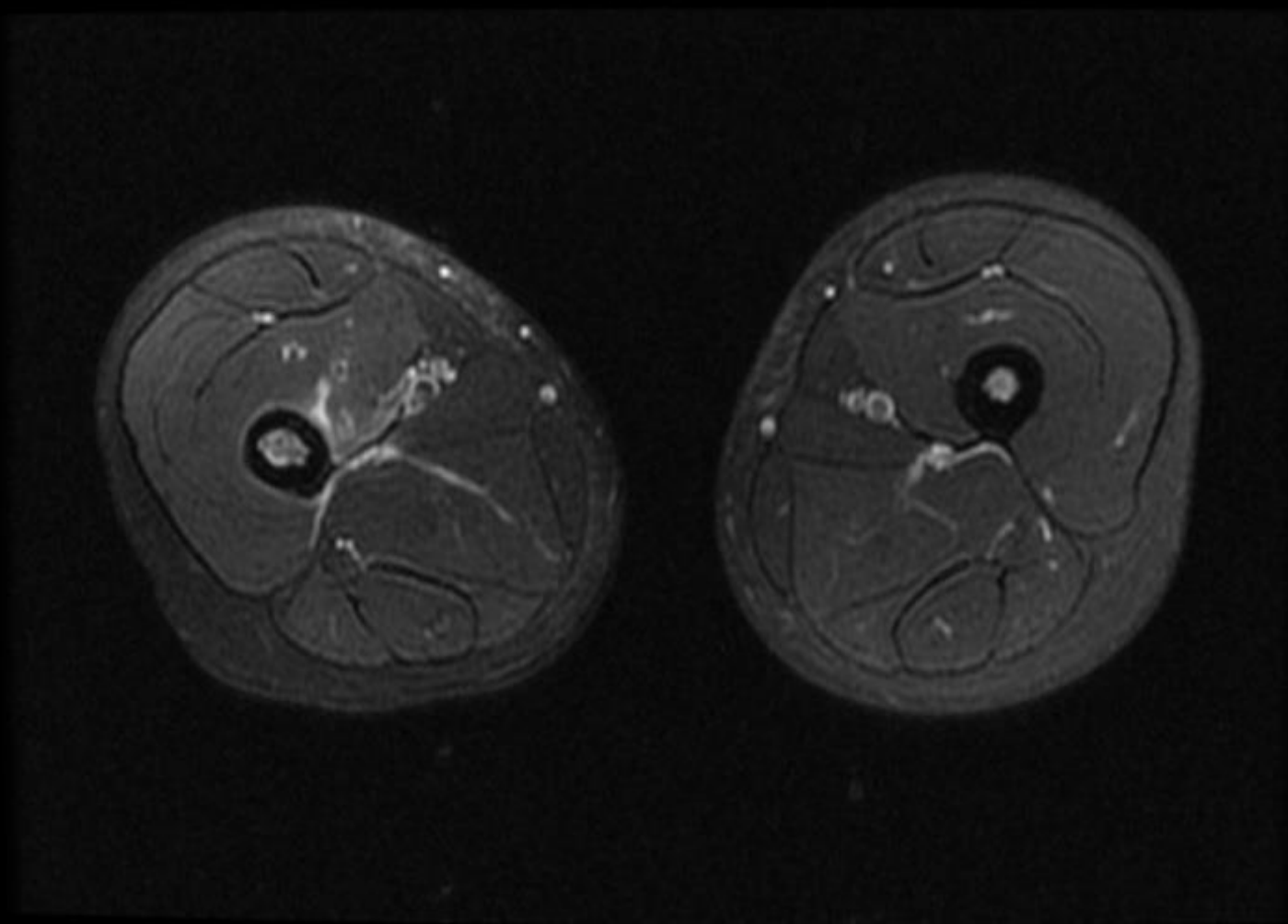












Child with Sickle Cell disease and acute leg pain: DX INFARCTION

LEARNING POINTS: IN SICKLE CELL

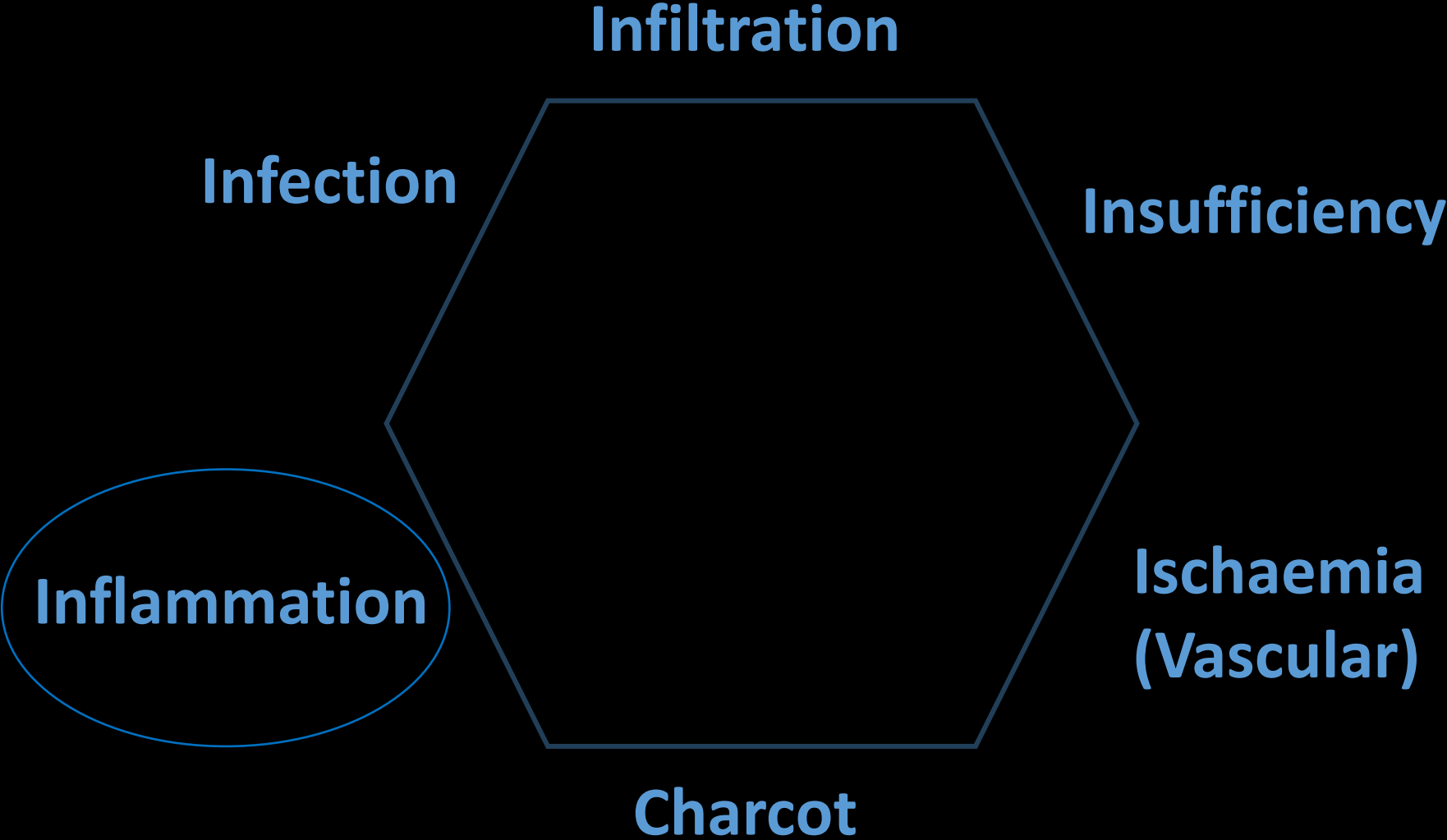
1. Periosteal fluid and bone marrow oedema can occur in both infarction and infection
2. Infarction and infection can co-exist
3. Cloaca/cortical breach is a specific sign of infection
4. Infection vs infarction is a clinical/team diagnosis



Axial T2 fat saturated MRI R Femur
Dx: Acute Infarction with bone marrow oedema and periosteal oedema, no infection

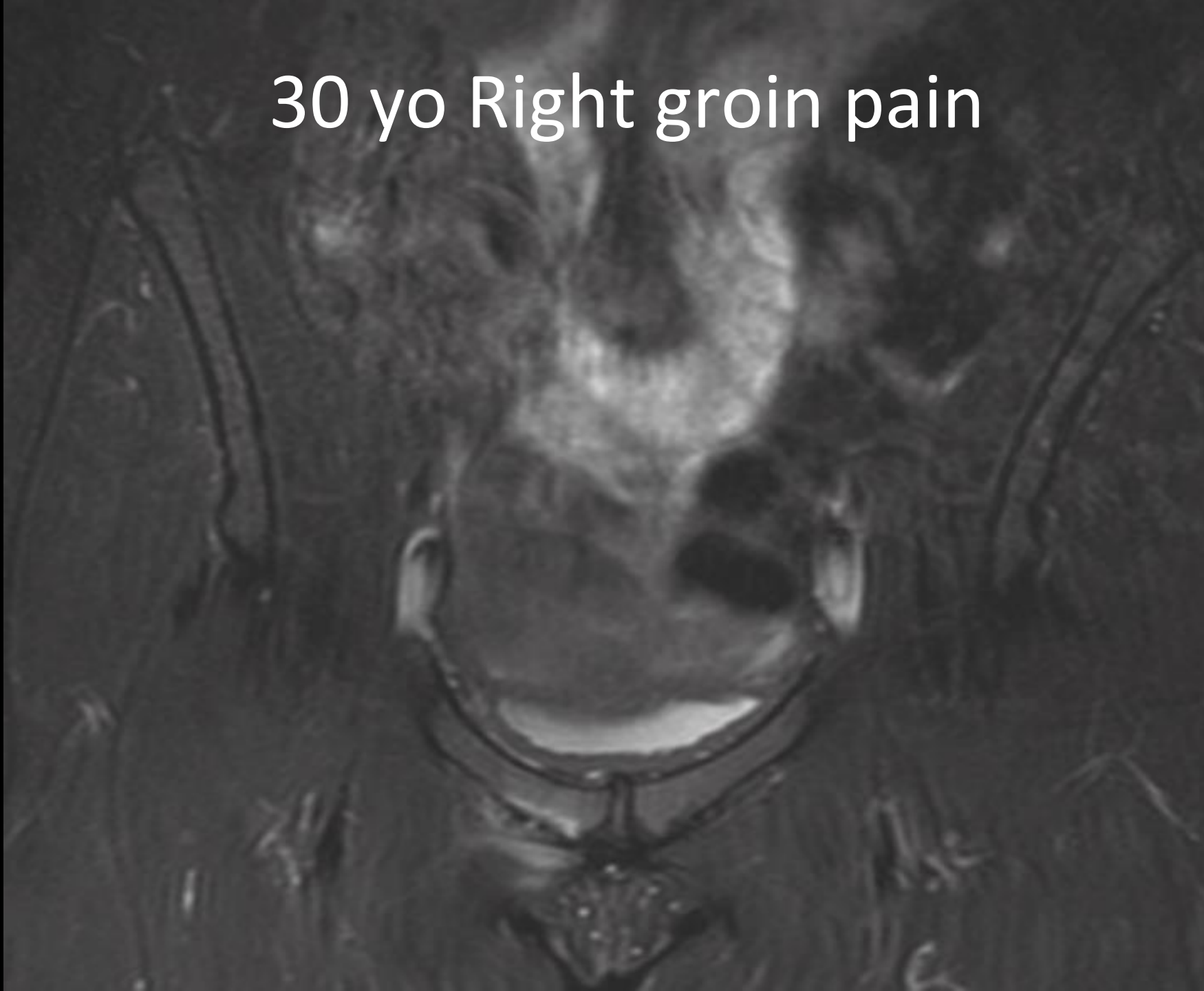


Causes of Bone Marrow Oedema (BMO)



30 yo Right groin pain

30 yo Right groin pain



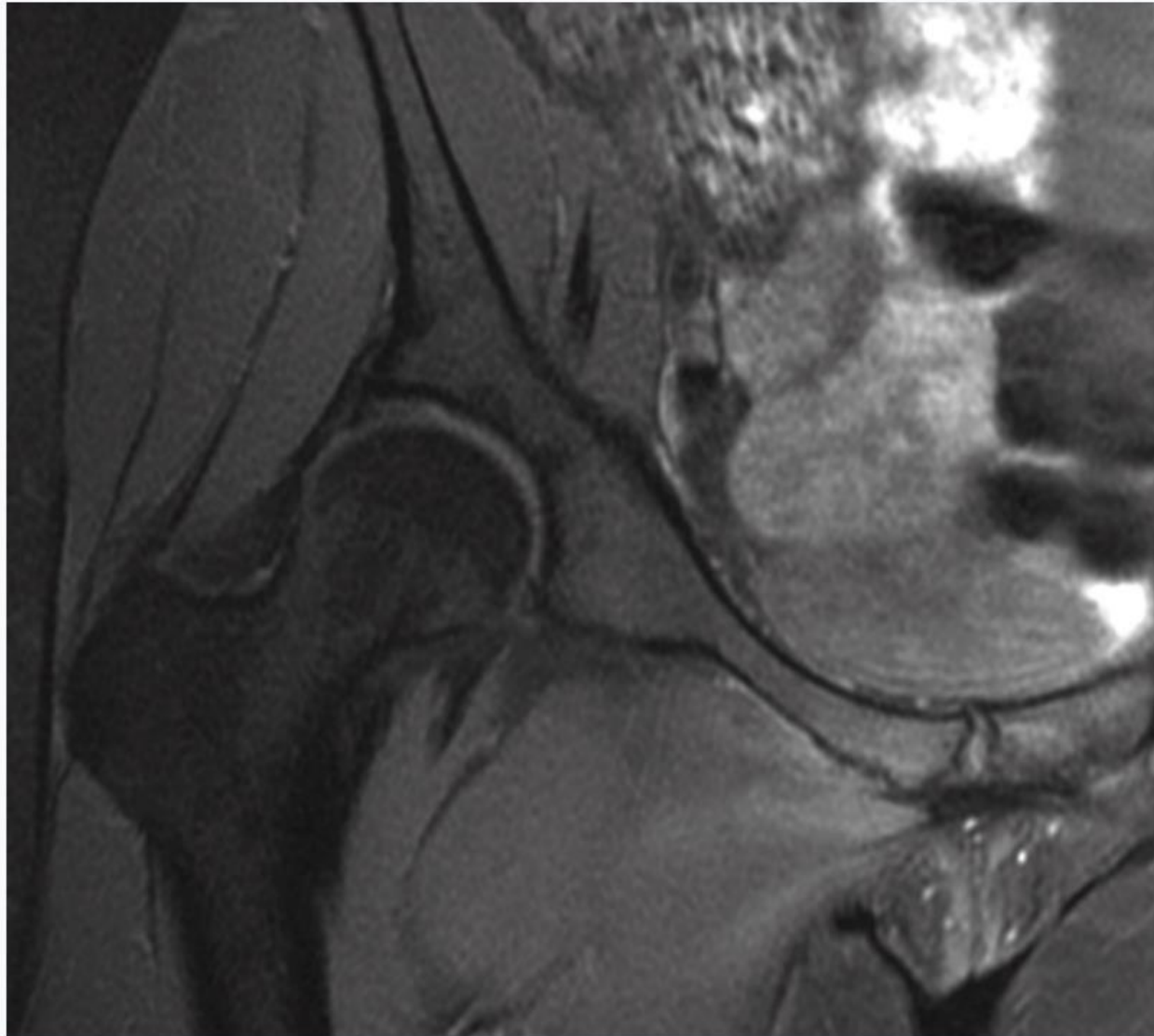
30 yo Right groin pain



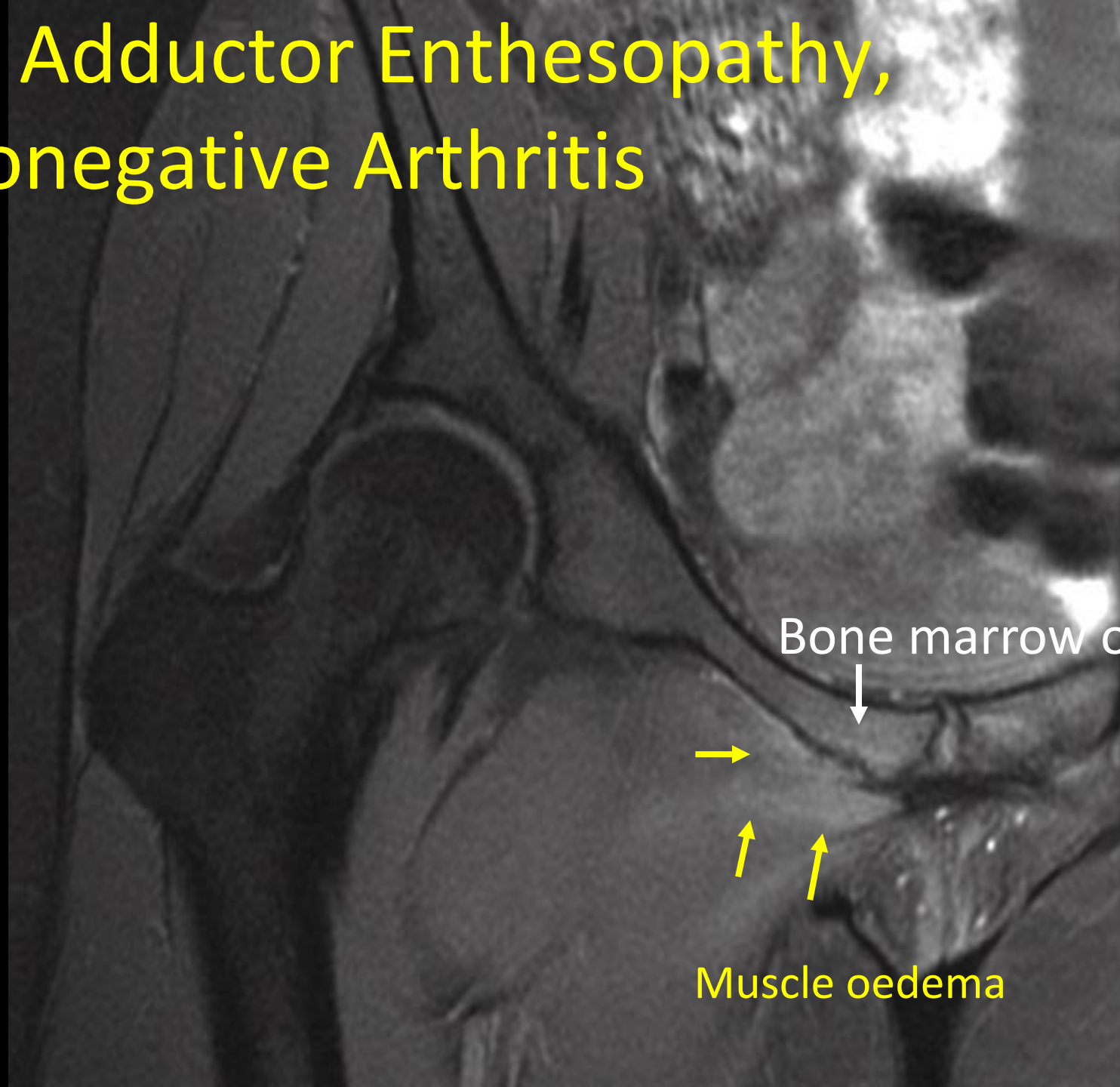
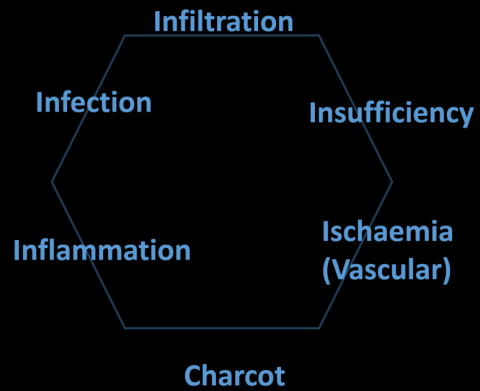
30 yo Right groin pain



Where is the abnormality



Diagnosis: Adductor Enthesopathy, Seronegative Arthritis



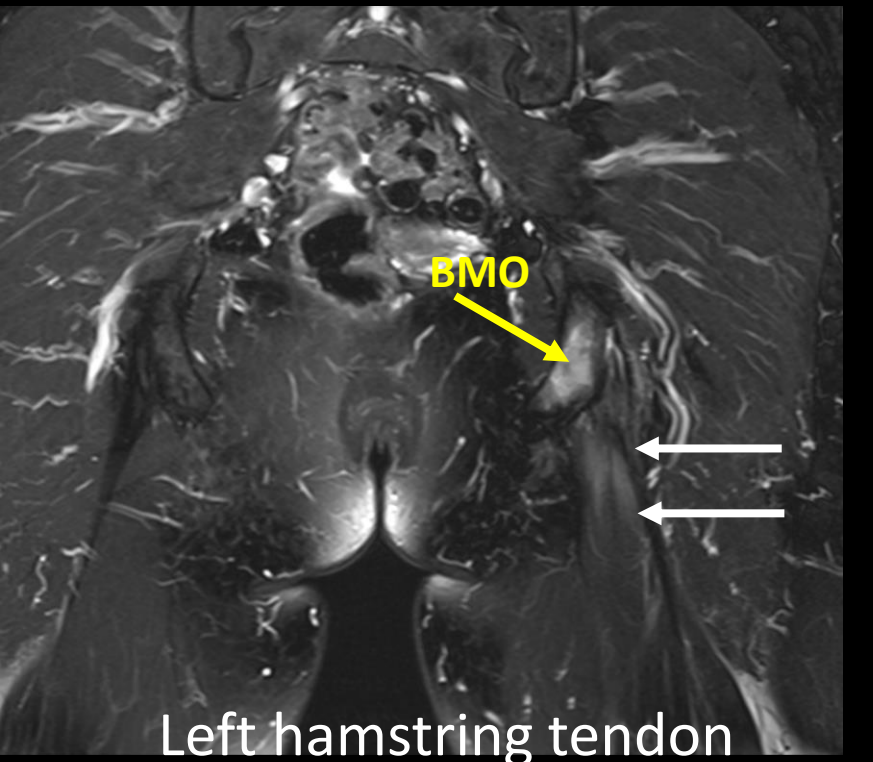
Bone marrow oedema, erosions



Muscle oedema

Companion Cases: Inflammatory Arthritis

#1.L hamstring enthesopathy

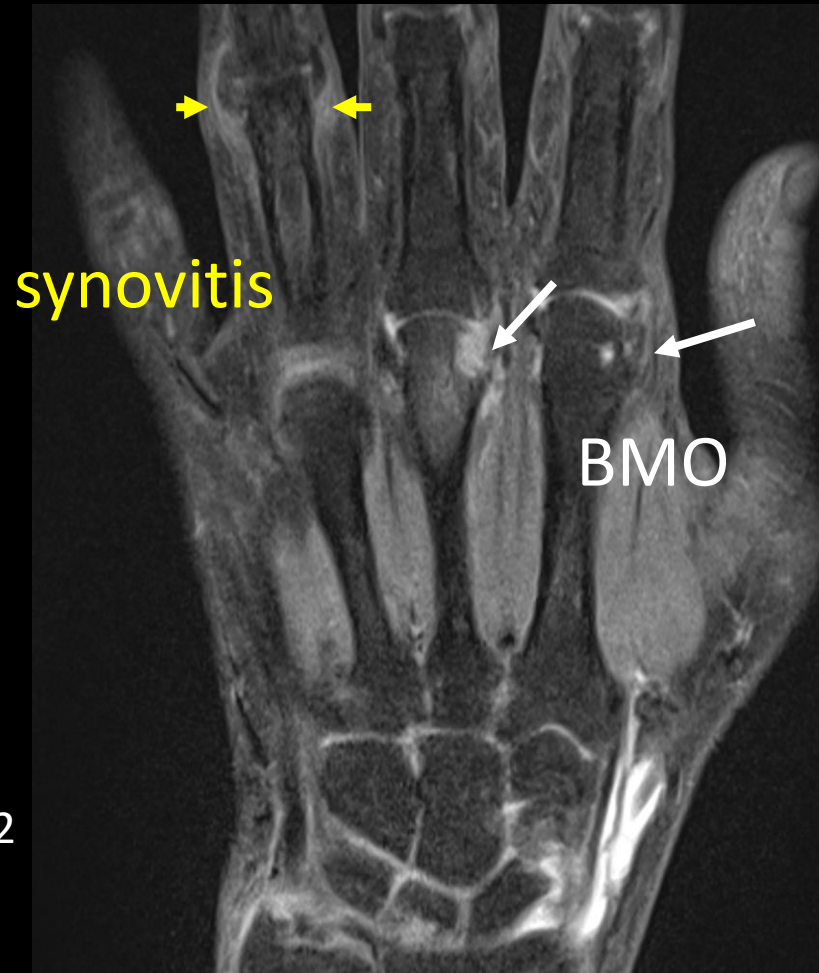
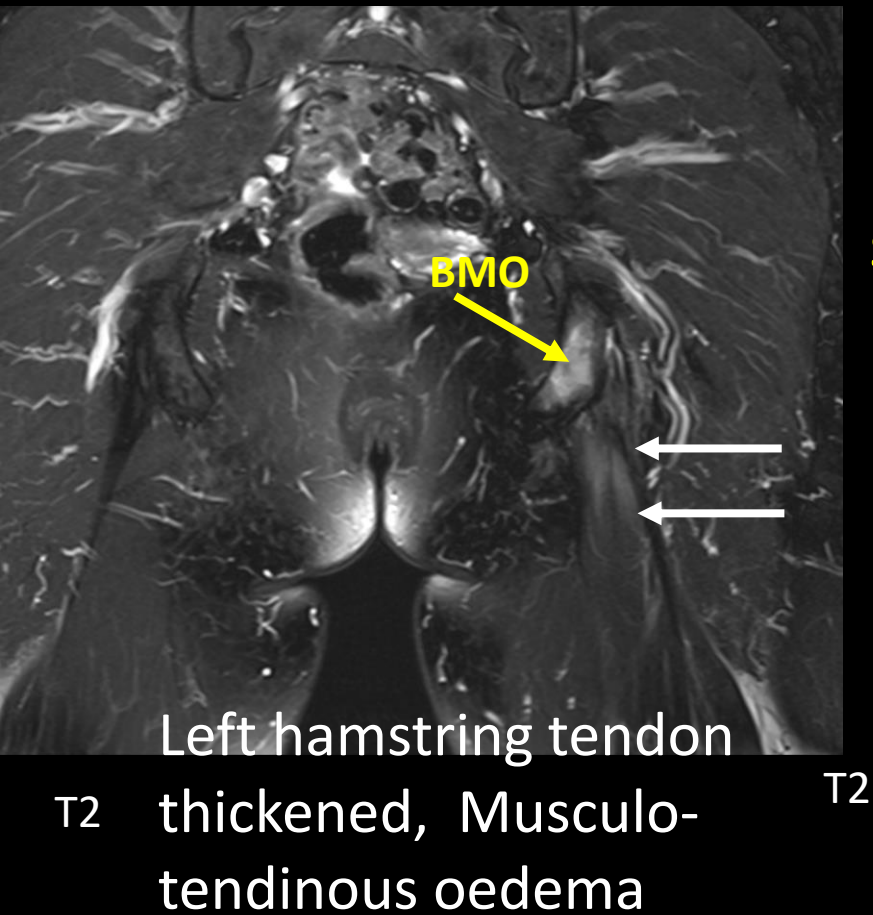


T2 Left hamstring tendon
thickened, Musculo-
tendinous oedema T2

Companion Cases: Inflammatory Arthritis

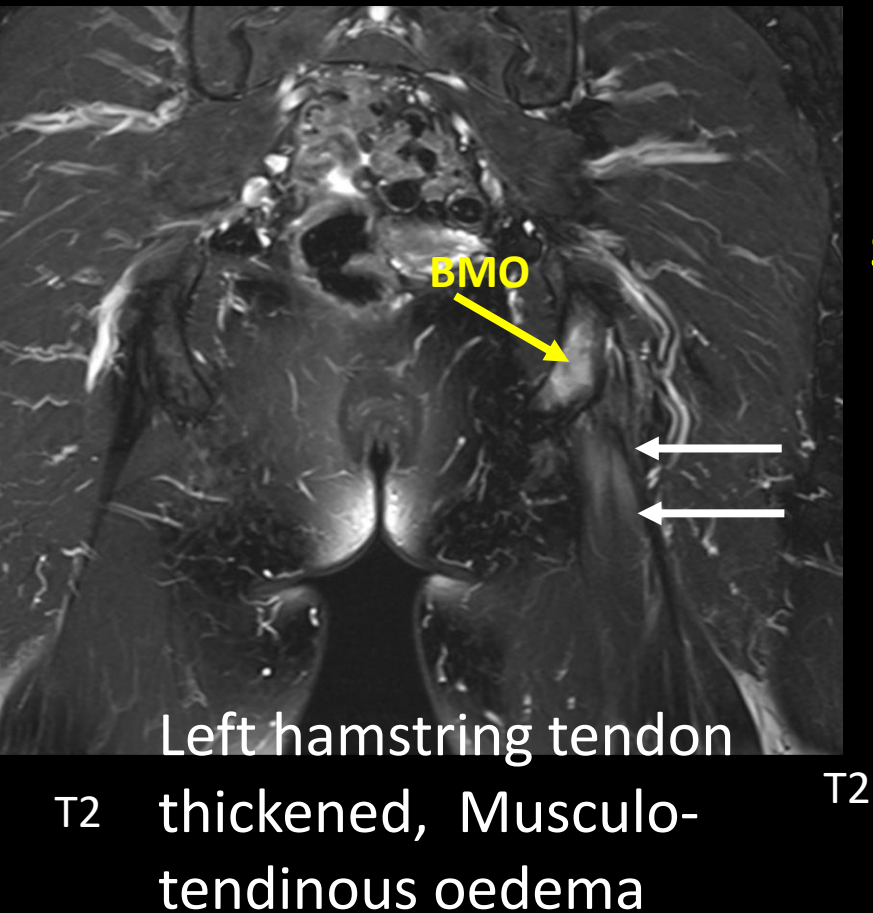
#1.L hamstring enthesopathy

#2.Rheumatoid A

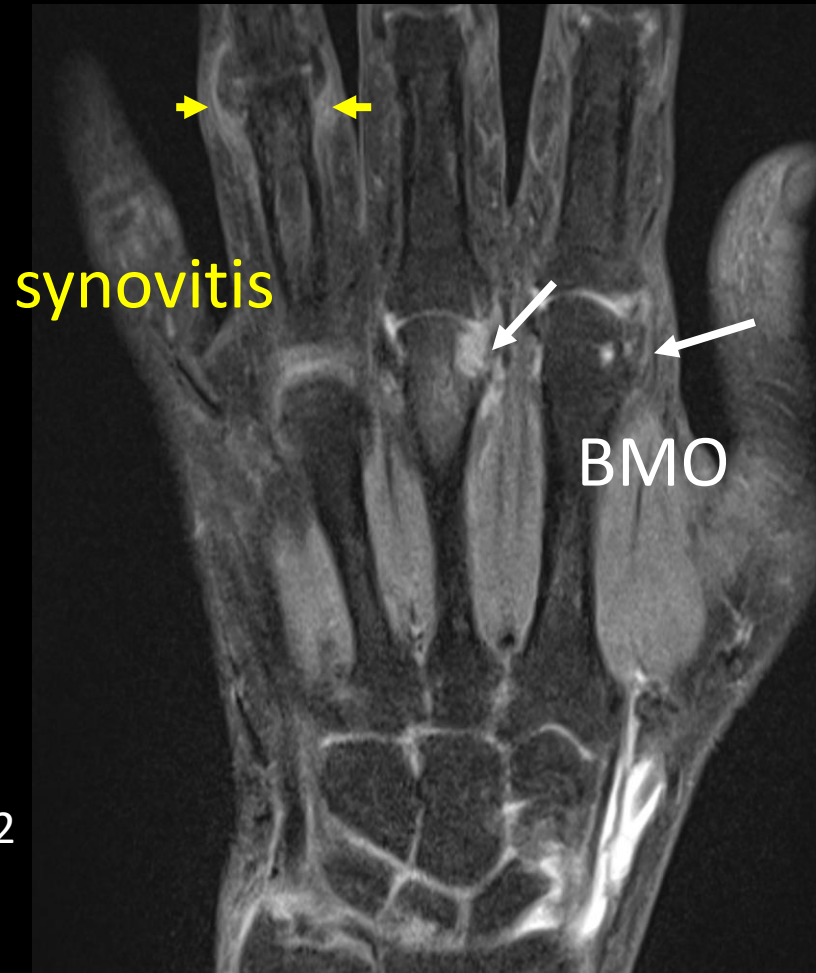


Companion Cases: Inflammatory Arthritis

#1.L hamstring enthesopathy



#2.Rheumatoid A

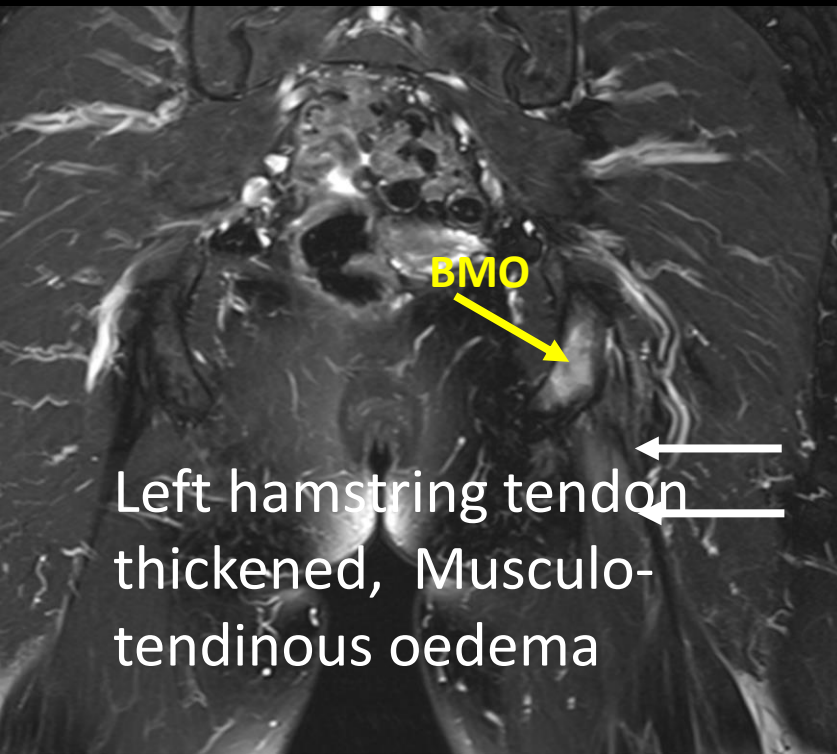


Learning Point: Bone marrow oedema often occurs at bare areas (no articular cartilage) where pannus/synovitis interacts with underlying bone

Companion Cases: Inflammatory Arthritis

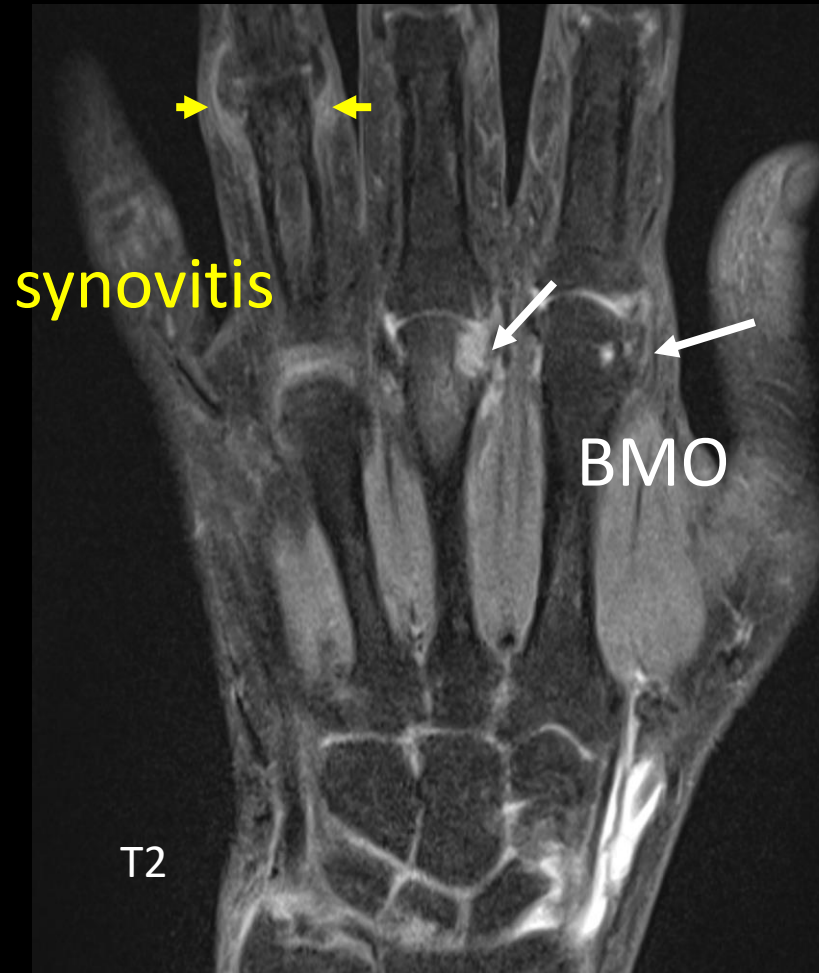
Learning Point: Joint centred process?
Exclude infection!

#1.L hamstring enthesopathy



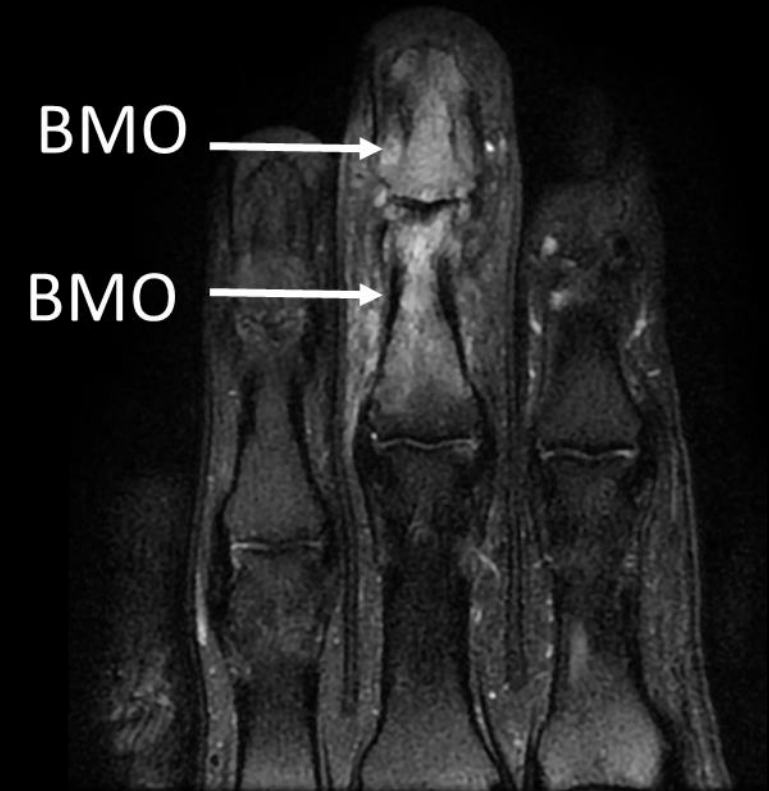
T2

#2.Rheumatoid A

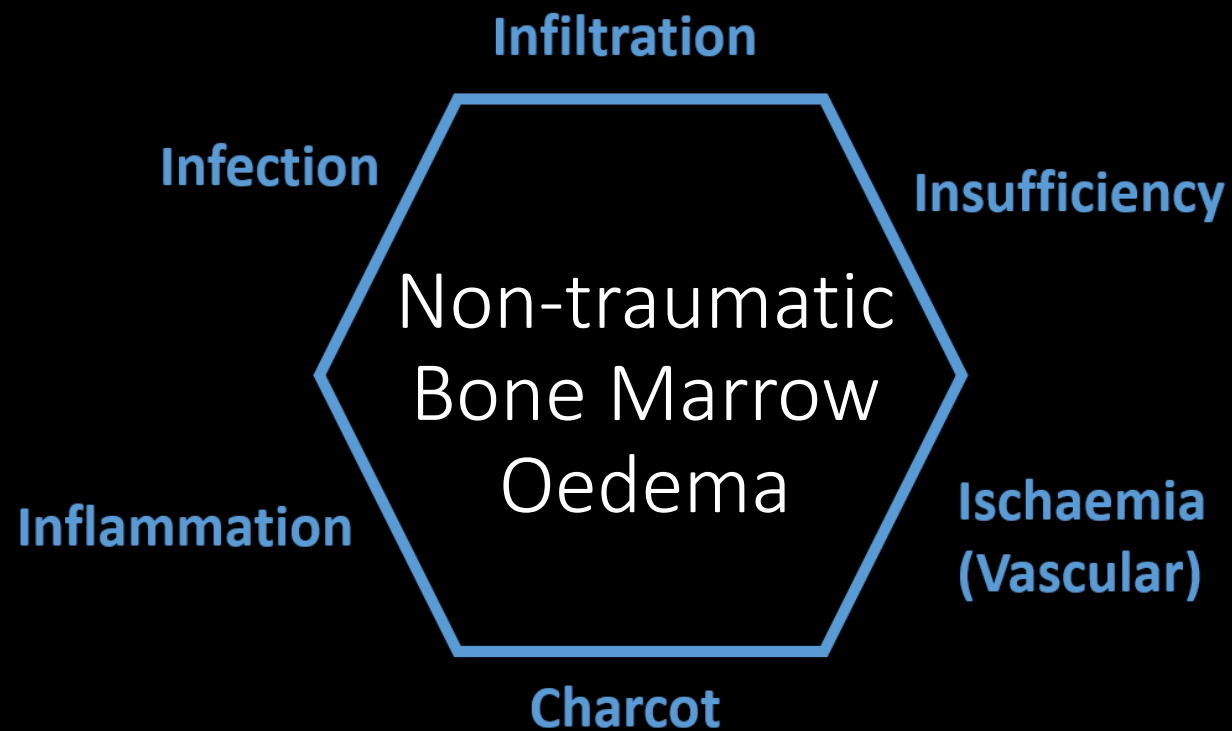


T2

#3.Psoriatic Arthritis



T2





Thank You

Dr Marcela de la Hoz Polo

Dr Dimitri Amiras

Dr Syed Babar

Dr Miny Walker

Dr Lisa Meacock

Dr Anne Kinderlerer

Dr Afshin Alavi

Prof Wady Gedroyc

Prof On Min Kon

Mr Reza Mobasheri

Mr Nadeem Mushtaq

Mr Peter Rosenfeld

Dr Anish Raithatha

Dr Amandeep Sandhu

Dr Susan Hesni

