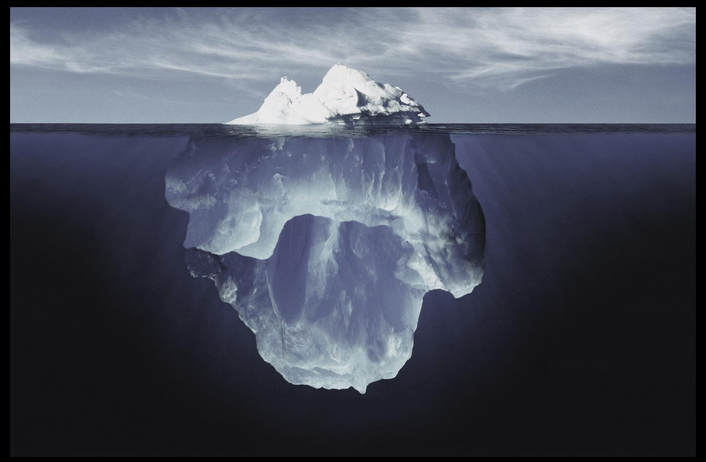
Fracture: Uncovering the Hidden Concerns



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MEDICAL SCHOOL

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GE Healthcare Research Consultant

Scenario

20-year-old male with acute right hip pain after the Boston marathon, normal Xray

Stress (Fatigue Fx)

Scenario

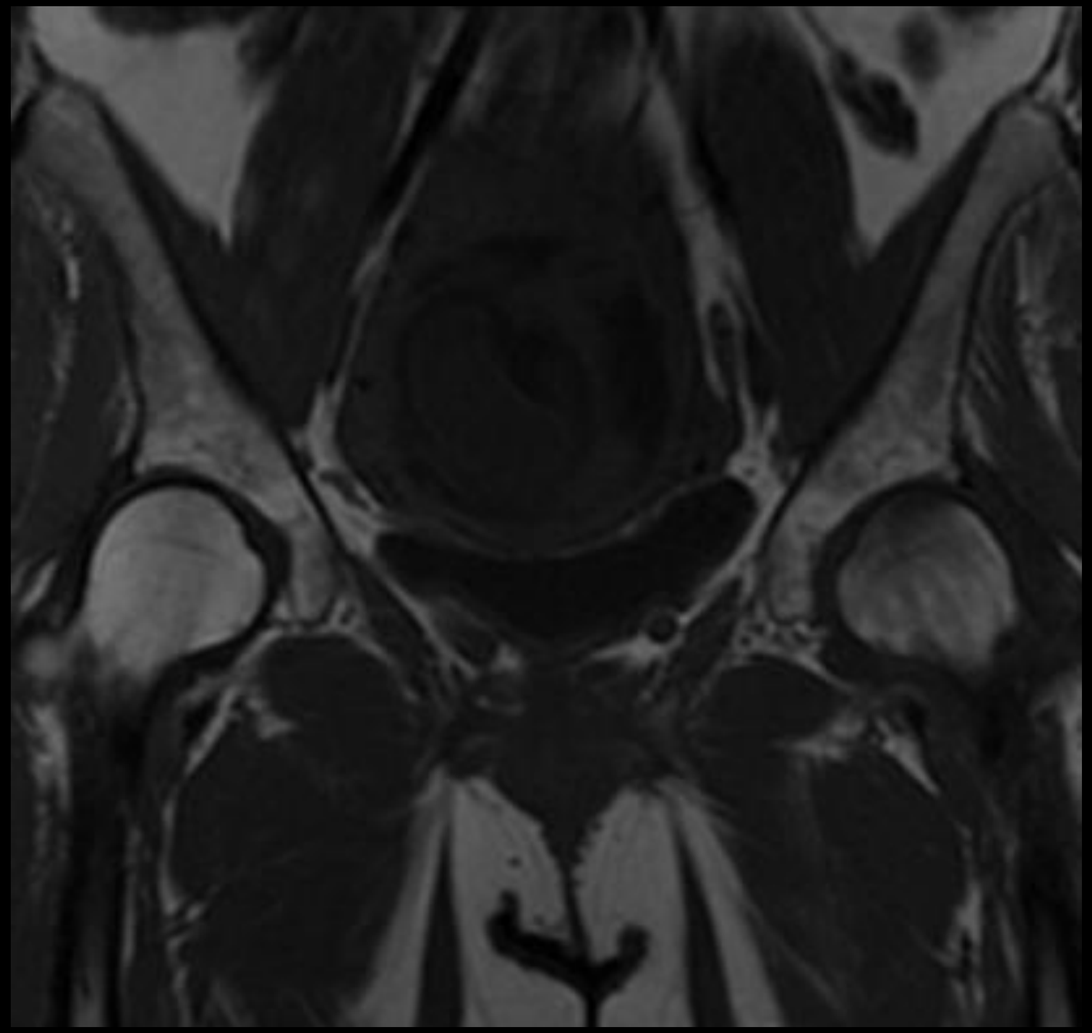
76-year-old with acute left hip pain

Subchondral insufficiency Fx

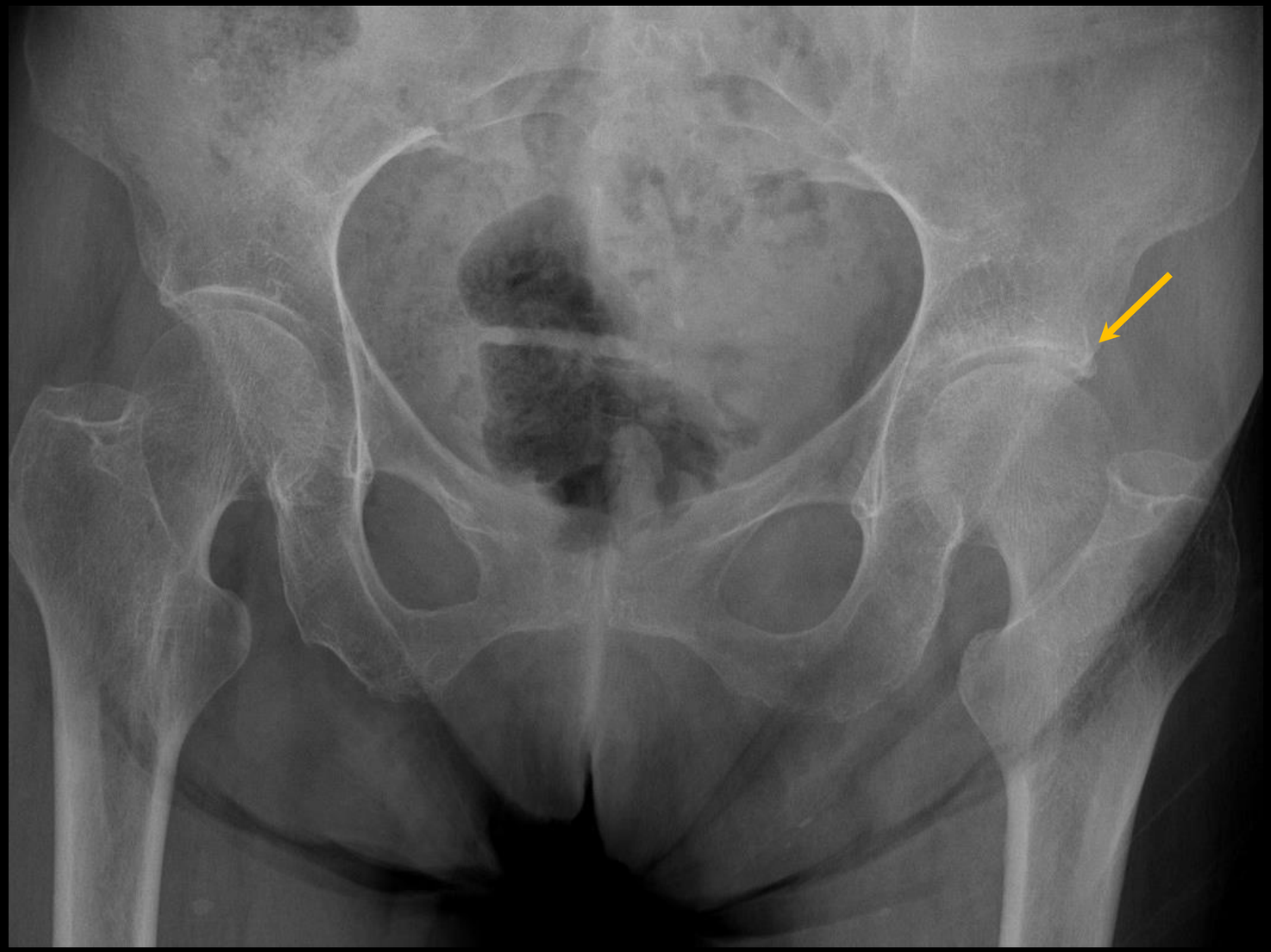
STIR Cor

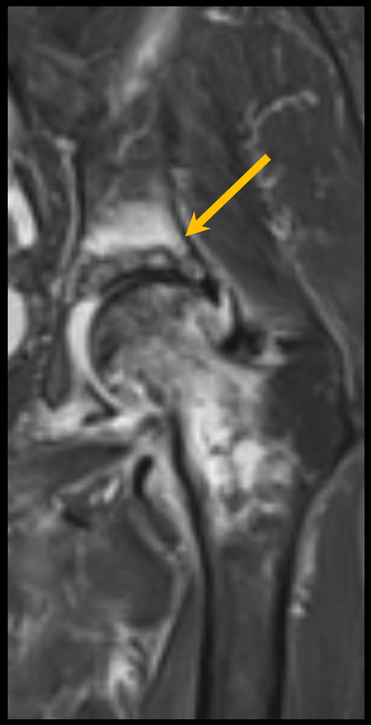
T1 Cor

Subchondral insufficiency Fx



Supracetabular insufficiency Fx

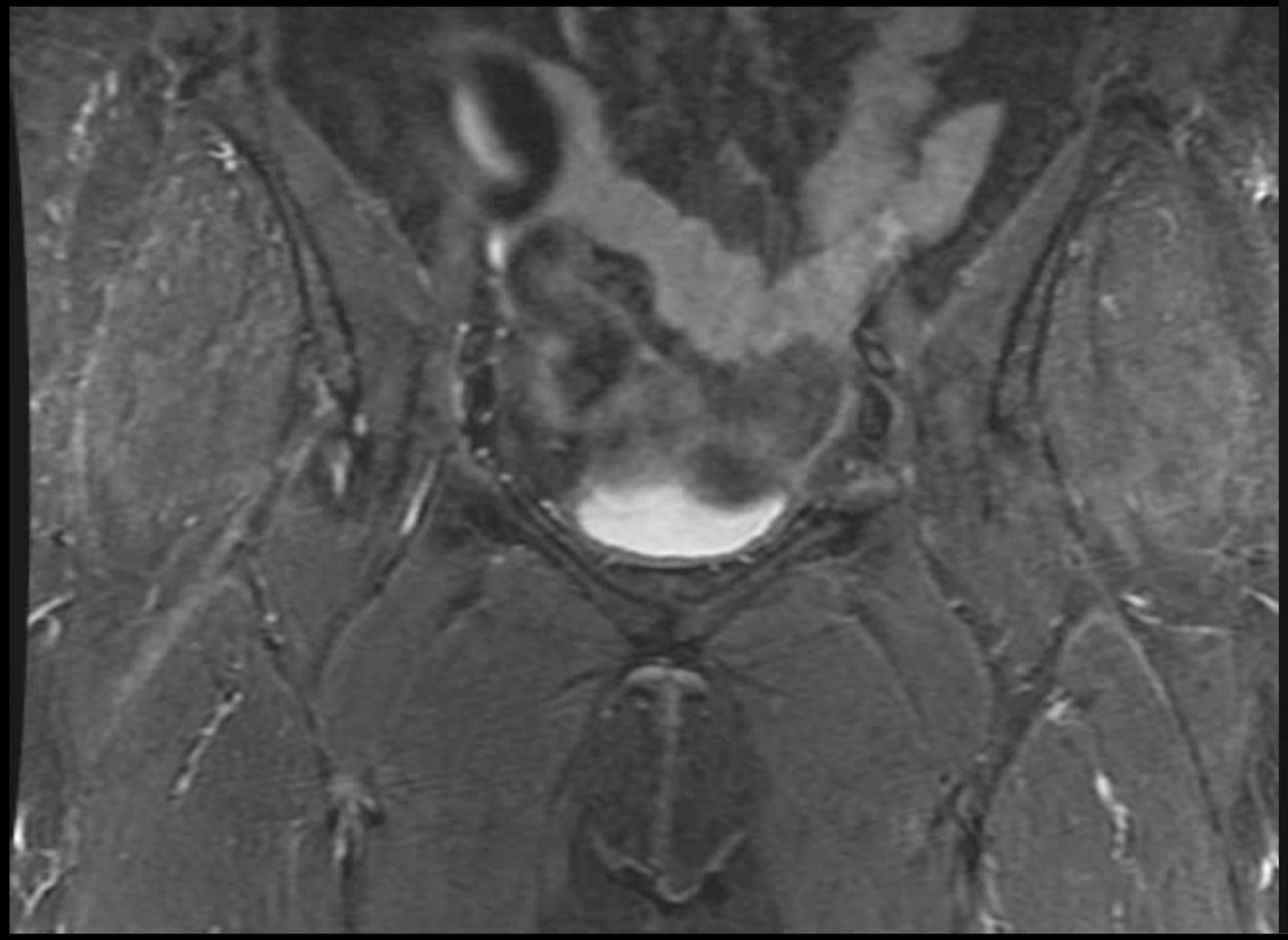


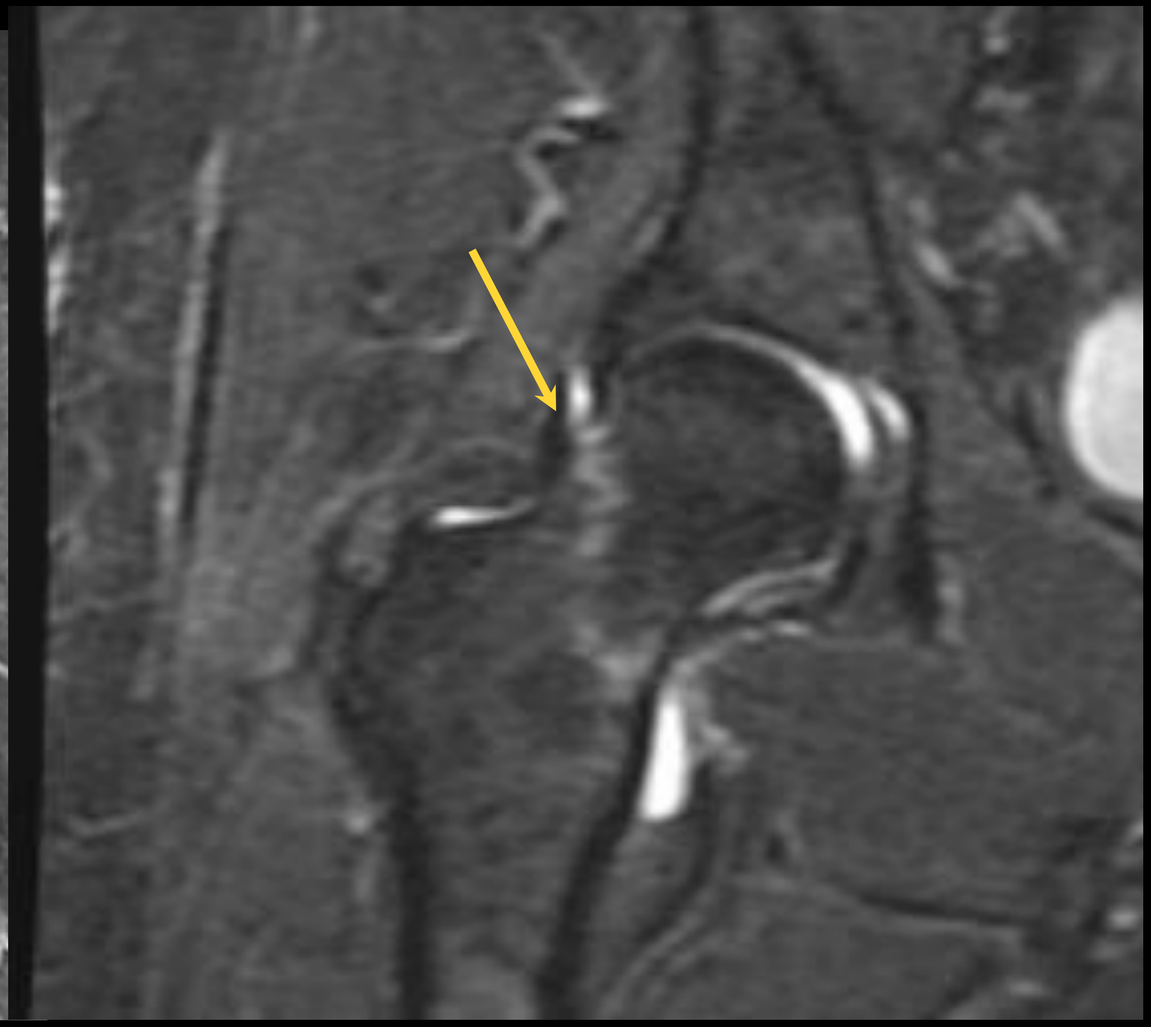


Scenario

37-year-old female attorney runner preparing for marathon presenting with acute right hip pain

? Stress Fx





Stress Fx

Insufficiency/Fragility Fx

Normal repetitive stress on bone with abnormal elastic resistance

- Osteoporosis, RA, Osteomalacia,
- Pelvic Bones, Tensile Cortex

Fatigue Fx

Abnormal repetitive stress on normal bone

- Runners
- Compressive cortex of femoral neck

Fatigue Compressive Stress Fx

STIR Cor

T1 Cor

Tensile Stress Fx

STIR Cor

T1 Cor

Not all stress fractures are cool

Fatigue Stress Fx

Cortical Bone

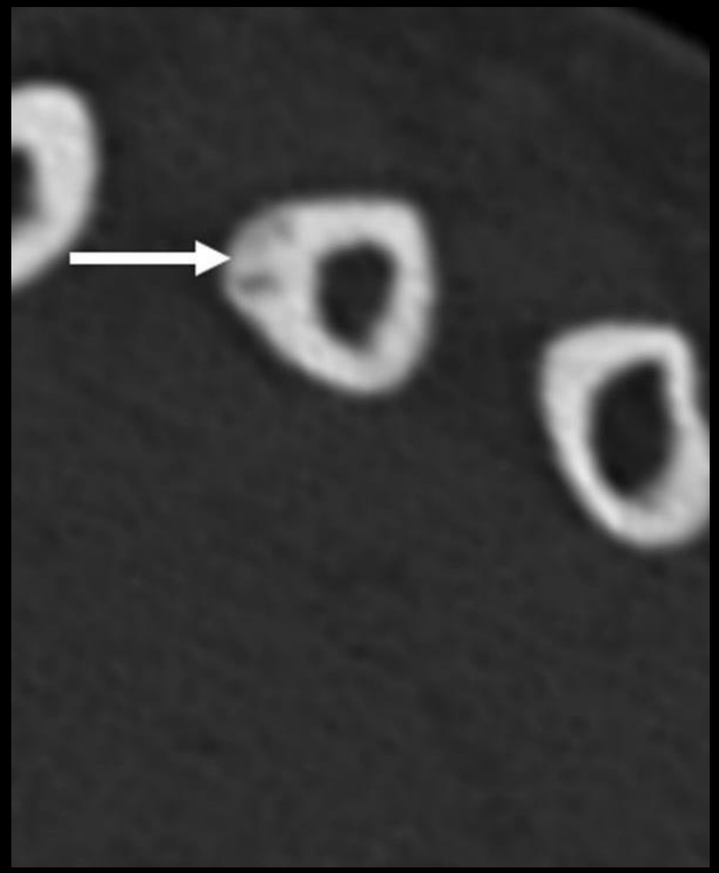
Trabecular Bone

Trauma/Emergency Radiology

Imaging Features and Management of Stress, Atypical, and Pathologic Fractures

Richard A. Marshall, Jacob C. Mandell, Michael J. Weaver, Marco Ferrone, Aaron Sodickson, Bharti Khurana

Gray Cortex Sign

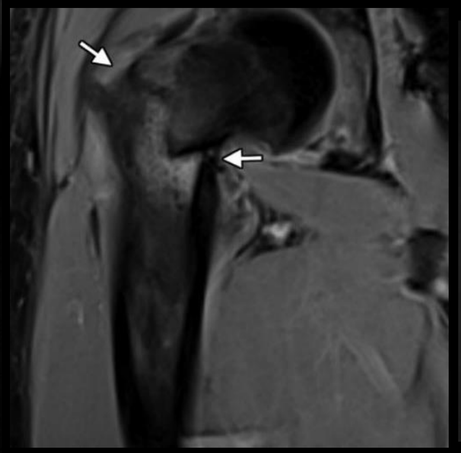


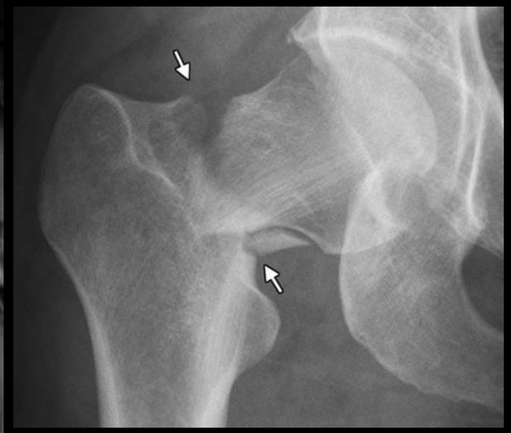
Jungmann PM, Schaeffeler C. Bone Stress Injuries at the Ankle and Foot. Semin Musculoskelet Radiol. 2023 Jun;27(3):283-292. doi: 10.1055/s-0043-1766098. Epub 2023 May 25. PMID: 37230128.

Stress Fx

LOW-RISK COMPRESSIVE FRACTURE

- Posteromedial tibia, Calcaneus, 3rd and 4th metatarsals, Medial femoral neck
- Activity modification and continued weight bearing



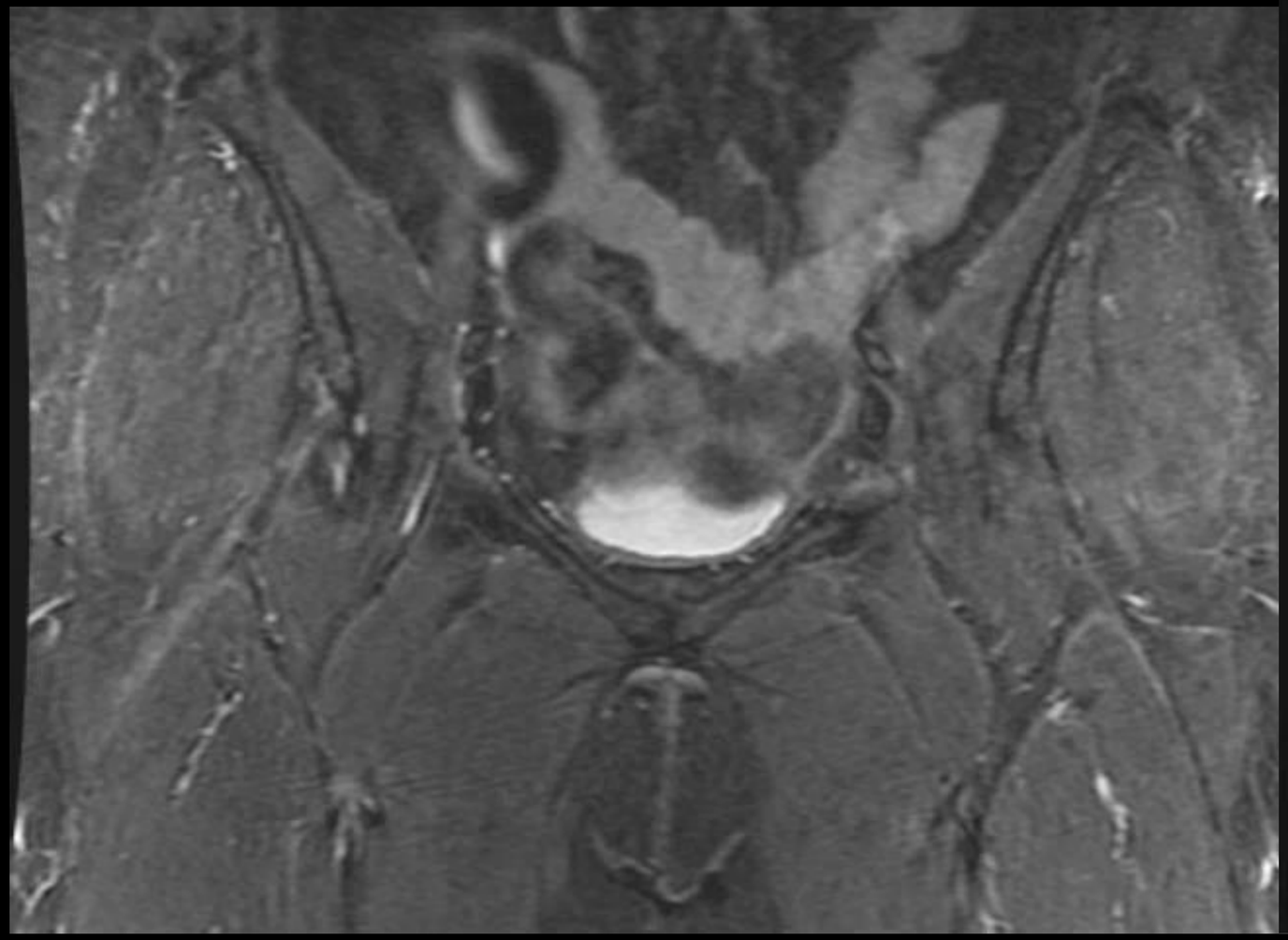


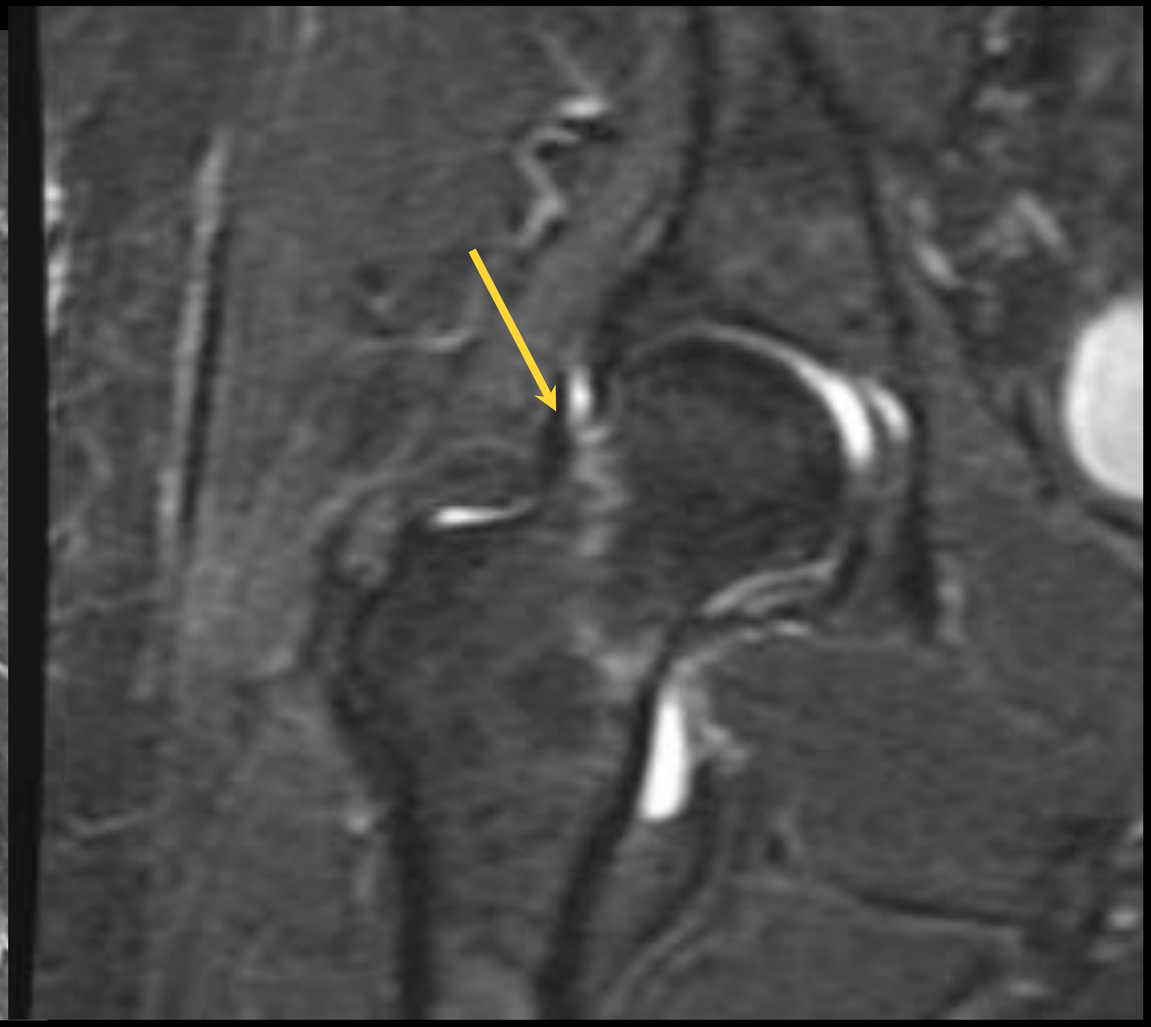
HIGH-RISK TENSILE FRACTURE

- Superolateral femoral neck, patella, anterior tibial cortex, medial malleolus, talar neck, dorsal navicular cortex, proximal metaphysis of 5th MT, Sesamoids of the great toe
- Poor vascularity, delayed union, or complete fracture
- Require aggressive management with protected weight bearing and even surgery.

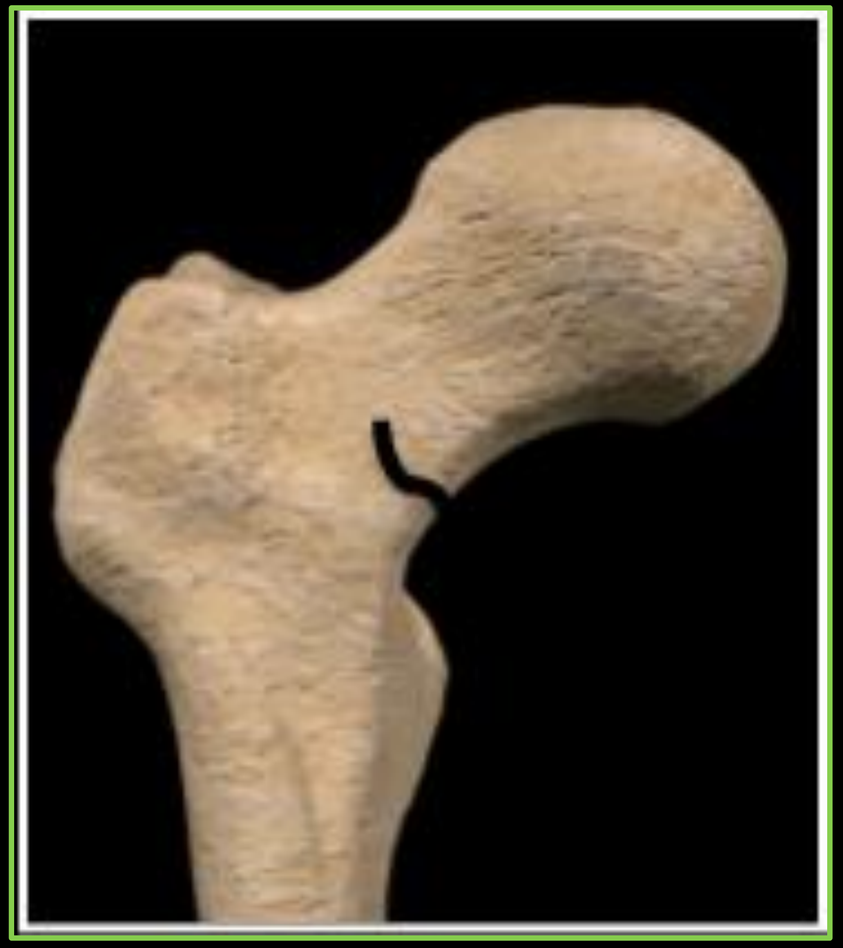
Low Risk Vs High Risk Stress Fx

Tensile Stress Fx





Femoral neck Stress Fx

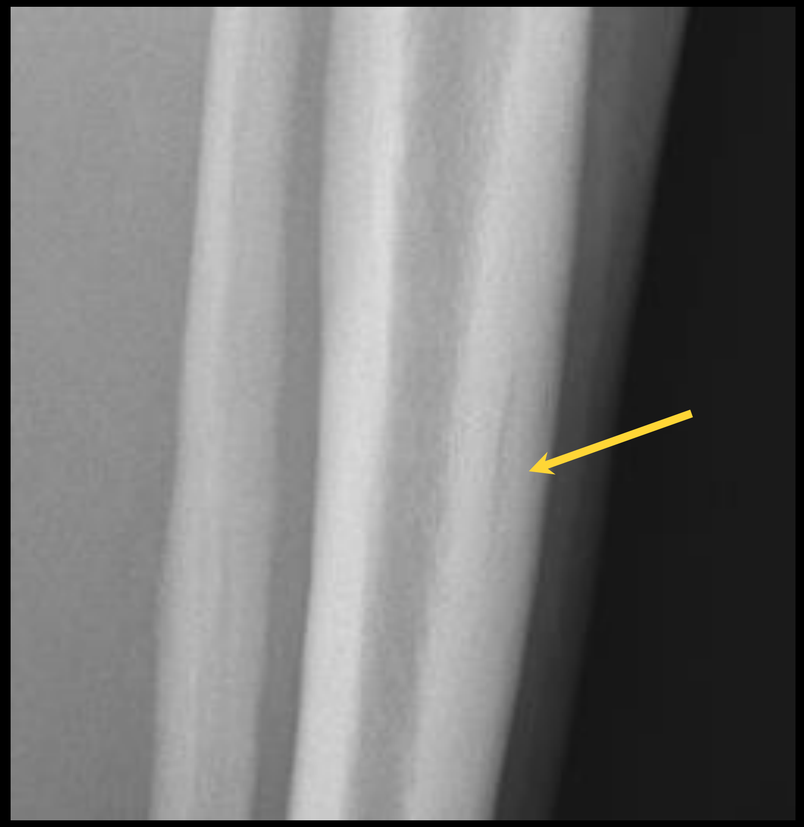


Compressive

Tensile

Displaced

Longitudinal Stress Fatigue Fx



Scenario

27-year-old male preparing for marathon

Low-Risk Compressive Fatigue Fx

Scenario

83-year-old woman, s/p fall from standing, acute left hip pain

How would you report this injury?

- **Displaced femoral shaft fracture**
- **Subtrochanteric fracture**
- **Pathologic subtrochanteric fracture**
- **Atypical subtrochanteric fracture**

Subtrochanteric Fx

- **Area from lesser trochanter to 5 cm distal**
- **Oblique/Spiral**
- **Significant shortening**
- **ORIF: Higher rates of failure**

Typical

Atypical

Thickened lateral cortex

Medial spiking

Absence of comminution

Transverse/short oblique

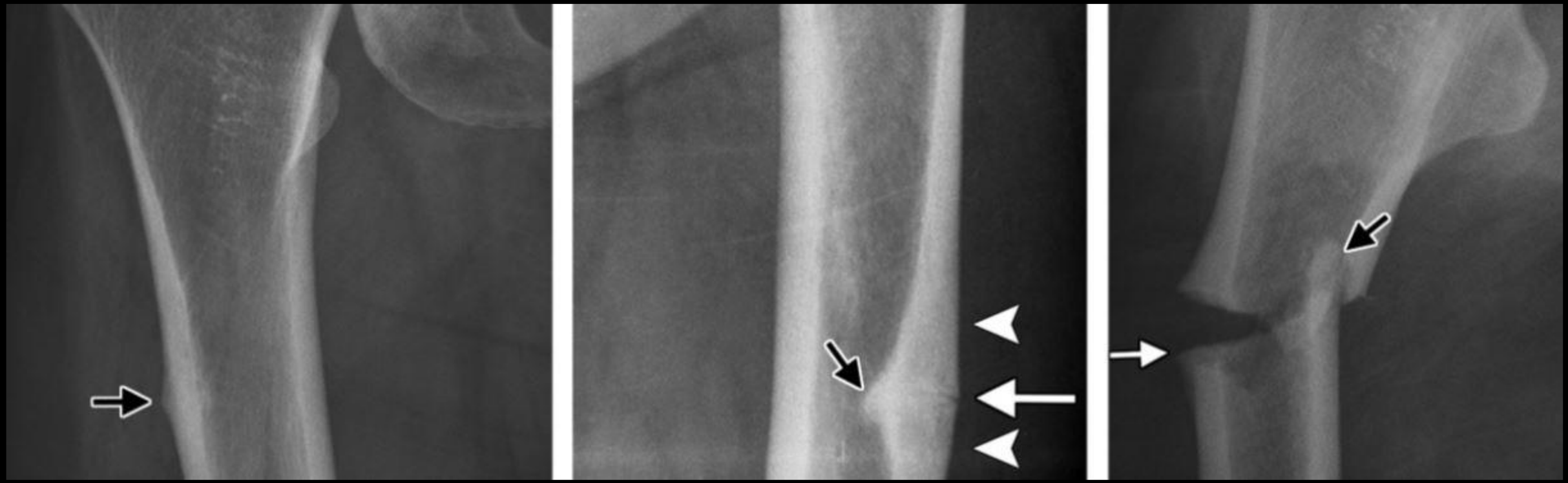
What is the best next step?

- **Further imaging with CT**
- **Further imaging with MRI**
- **Imaging of the contralateral femur**
- **Protected weight bearing with follow up radiographs in six weeks**

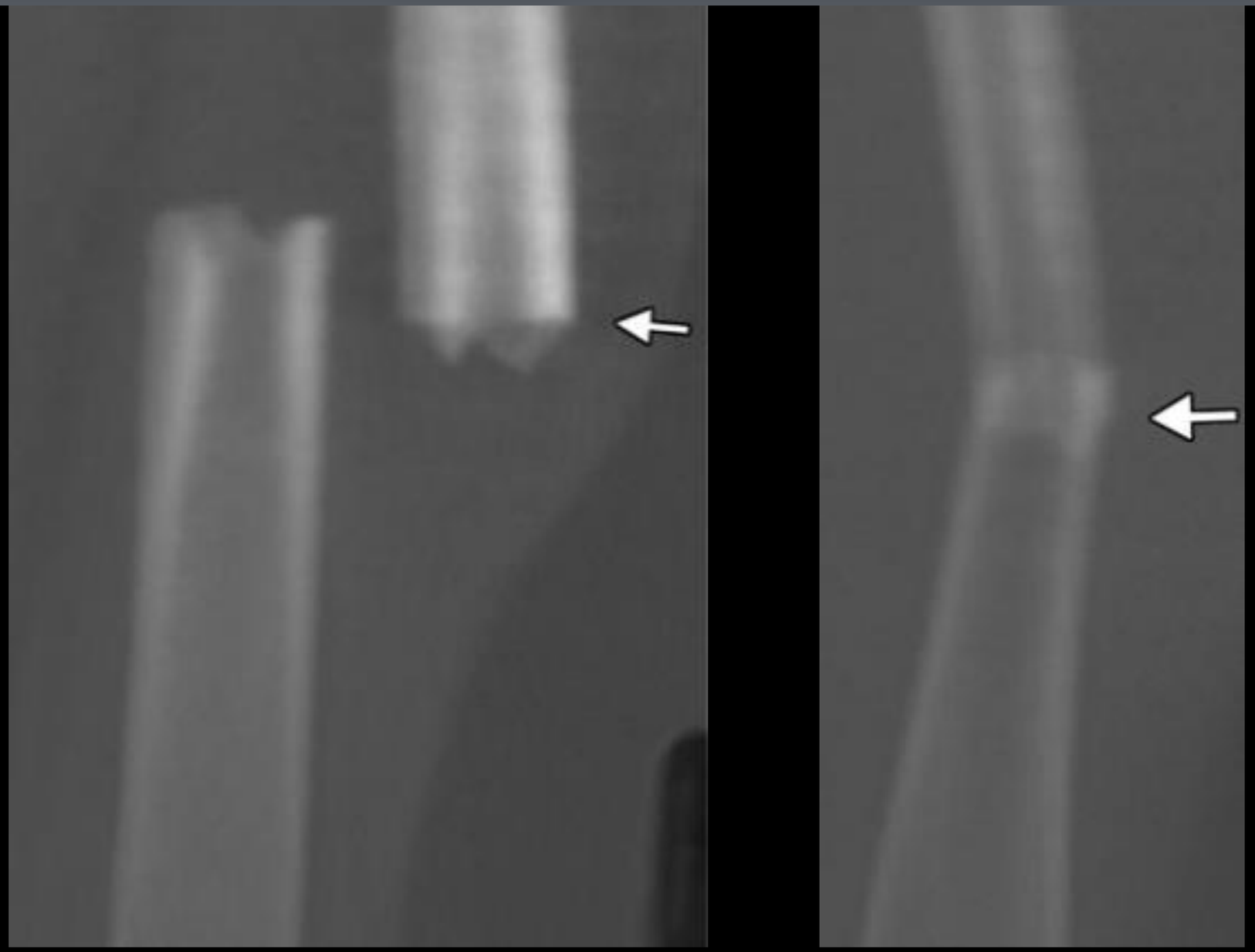
Atypical Femoral Fx

6 weeks

Atypical Femoral Fx



Differential



Atypical Femoral Fx

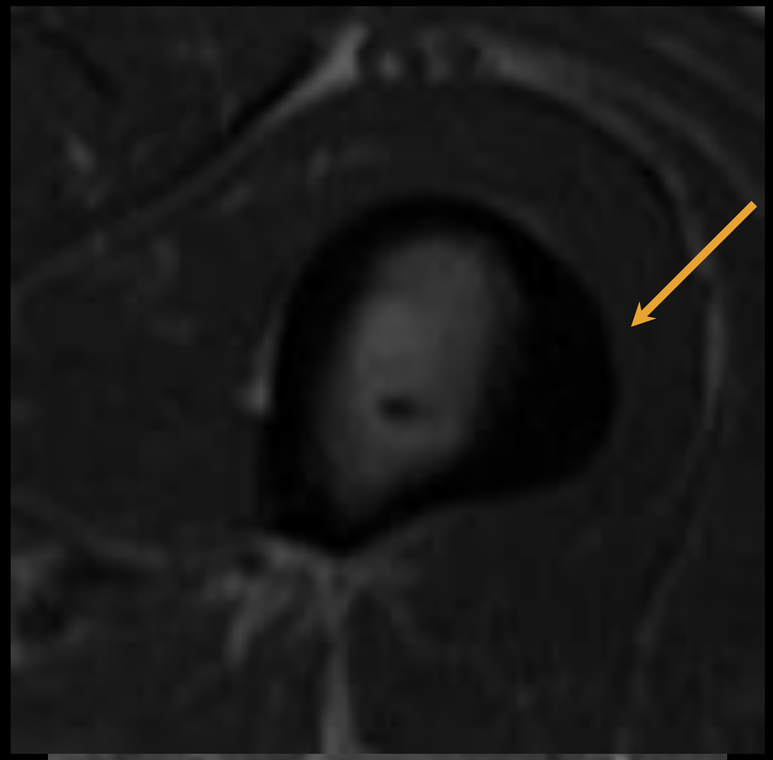
THE JOURNAL OF BONE & JOINT SURGERY · JBJS.ORG
VOLUME 95-A · NUMBER 2 · JANUARY 16, 2013

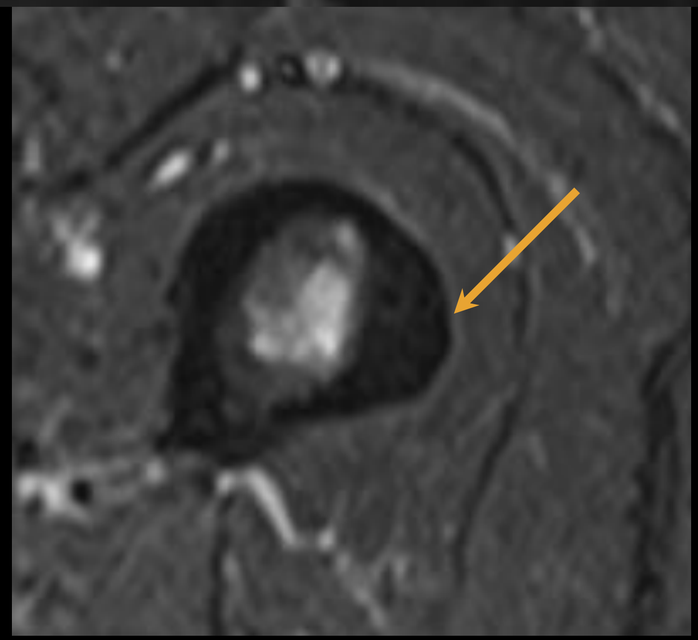
Aasis Unnanuntana, MD, Anas Saleh, MD, Kofi A. Mensah, MD, PhD, John P. Kleimeyer, BA, and Joseph M. Lane, MD

TABLE I Major and Minor Features for Diagnosing Atypical Femoral Fractures[15]*

Major Features	Minor Features
No history of trauma, or associated with low-energy trauma†	Localized periosteal thickening of the lateral cortex
Fracture located anywhere from distal to the lesser trochanter to proximal to the supracondylar area	Generalized thickening of the femoral cortices
Transverse or short oblique fracture configuration	Prodromal symptoms
Noncomminuted fracture	May be associated with bilateral fractures or symptoms
Medial spike in complete fractures; incomplete fractures involve only the lateral cortex	Evidence of delayed fracture-healing
	Comorbid conditions or the use of some medications‡

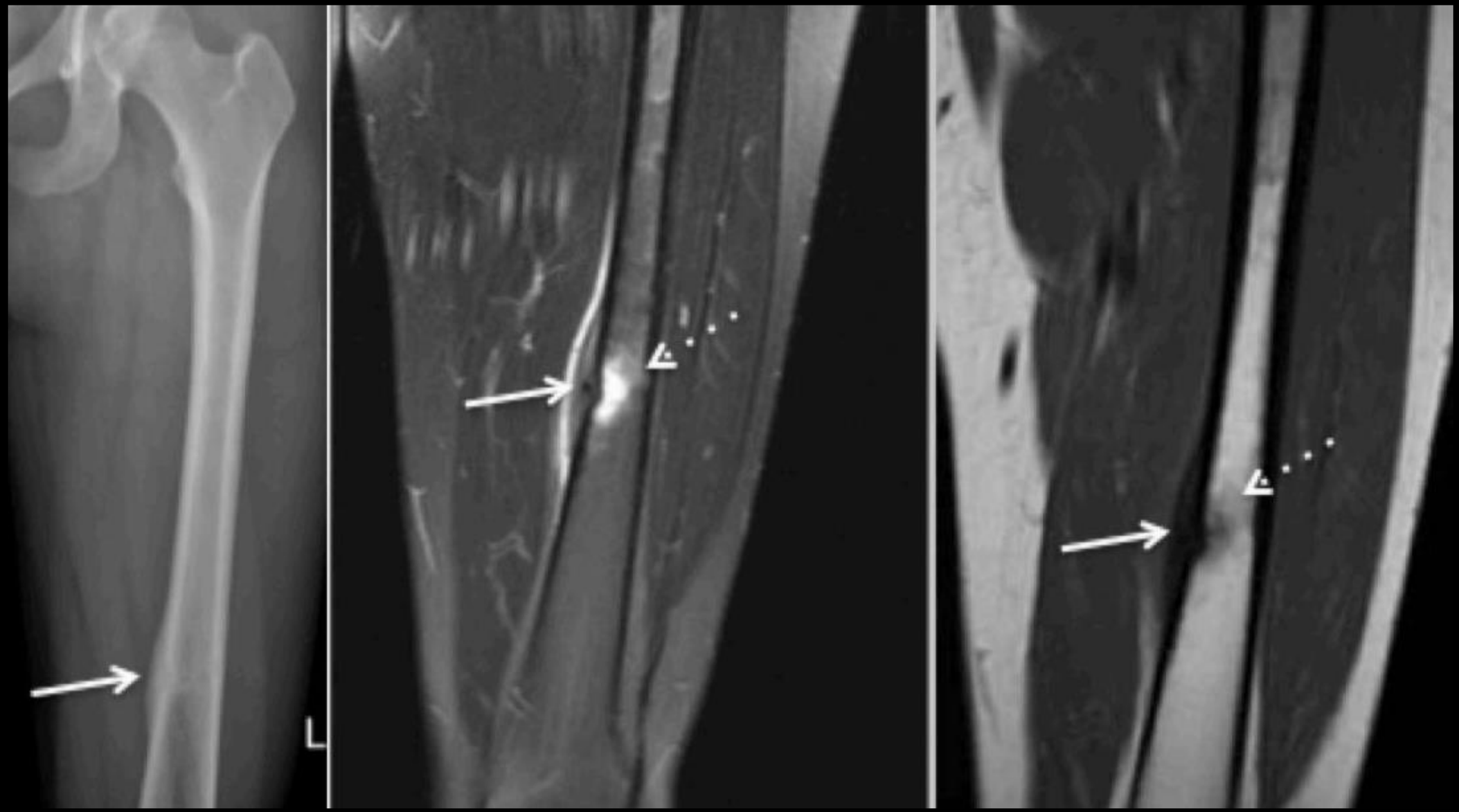
*All major features, accompanied by none or some of the minor features, are required to diagnose atypical femoral fractures. †Low-energy trauma is defined as a fall from a standing height or less. ‡Examples of comorbid conditions and medications are rheumatoid arthritis, rickets and osteomalacia, renal osteodystrophy, and the use of bisphosphonates, glucocorticoids, or proton pump inhibitors.





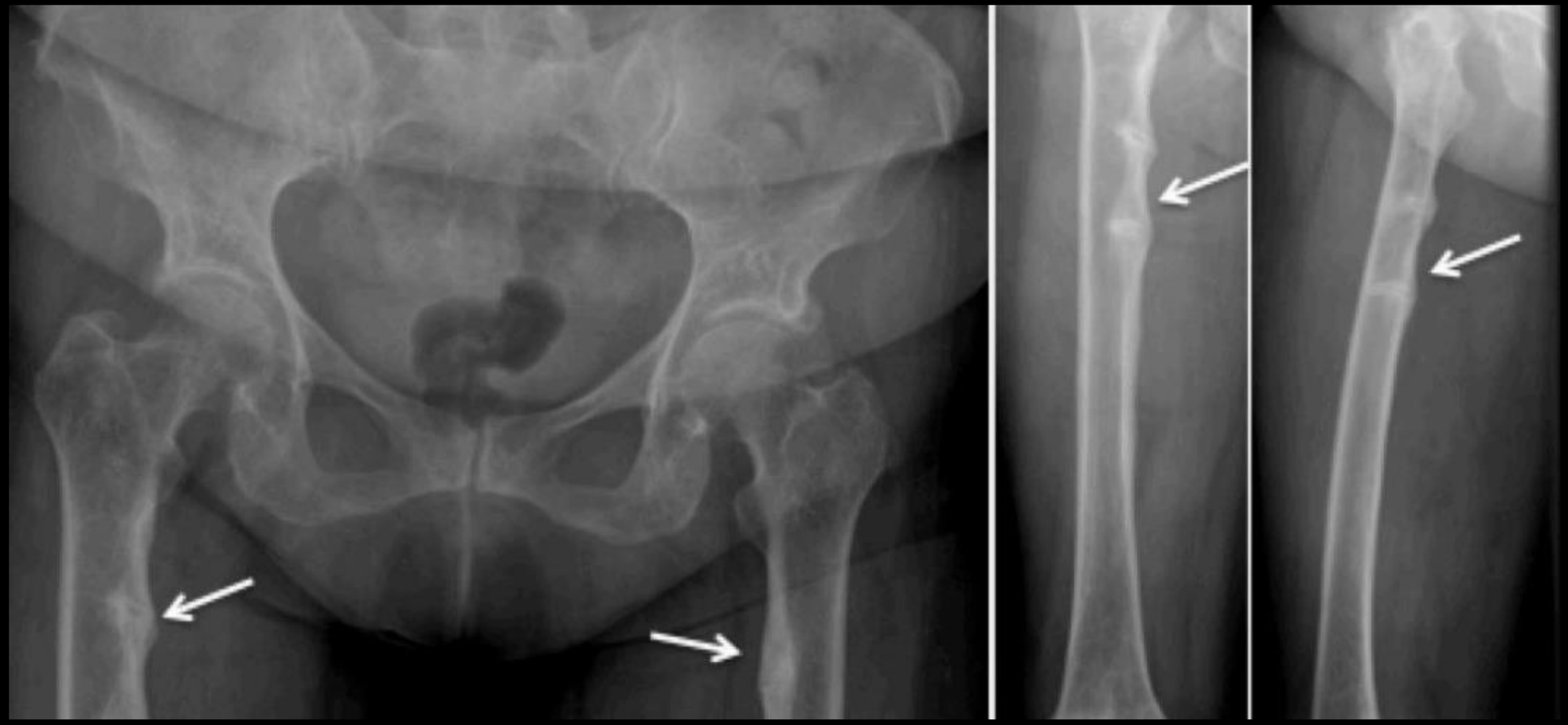
Some fractures are visible only when you understand the underlying pathology

Compressive Fatigue Femoral Fx



Hedge G, Thaker S, Botchu R, Fawcett R, Gupta H. Atraumatic fractures of the femur. Br J Radiol 2021; 94: 20201457

Looser Zones of Osteomalacia



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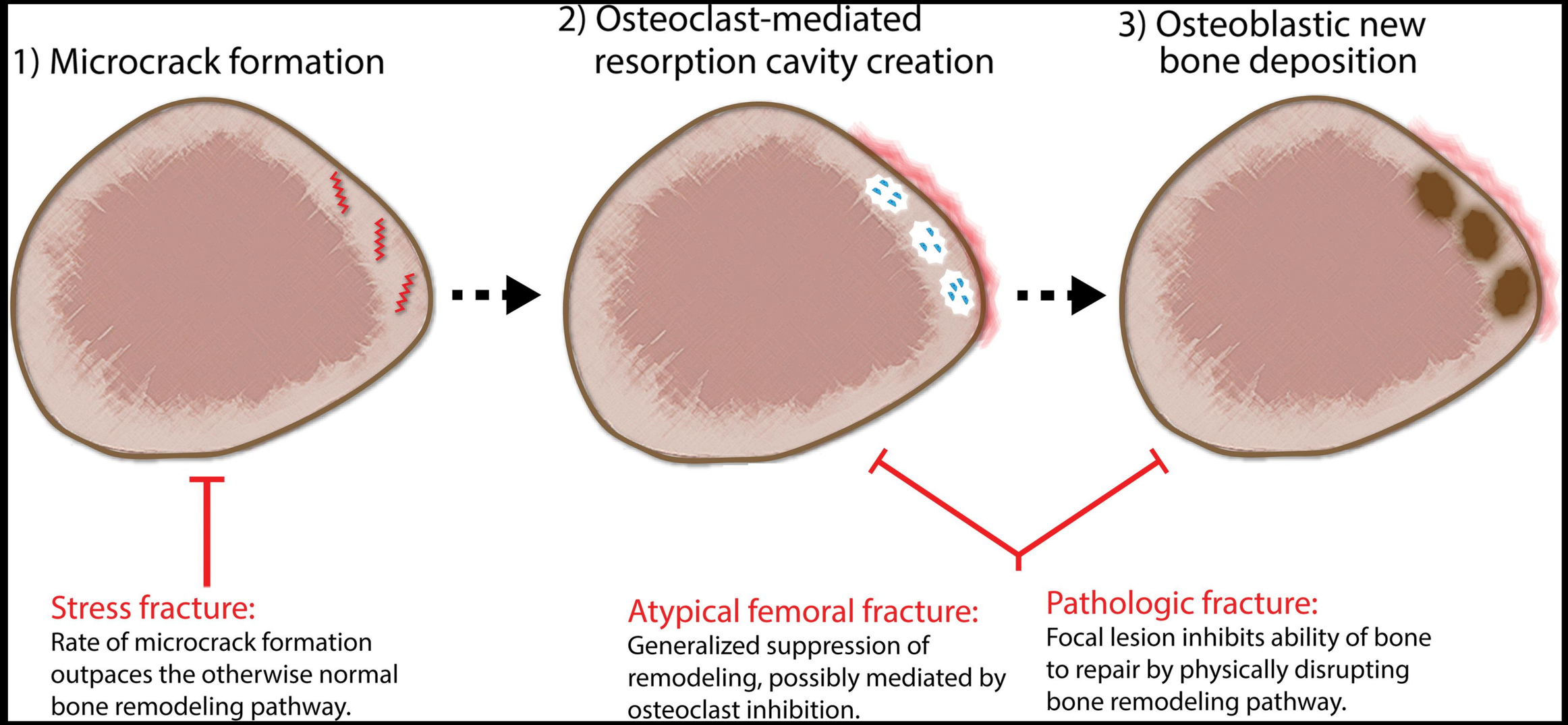

Trauma/Emergency Radiology

Imaging Features and Management of Stress, Atypical, and Pathologic Fractures

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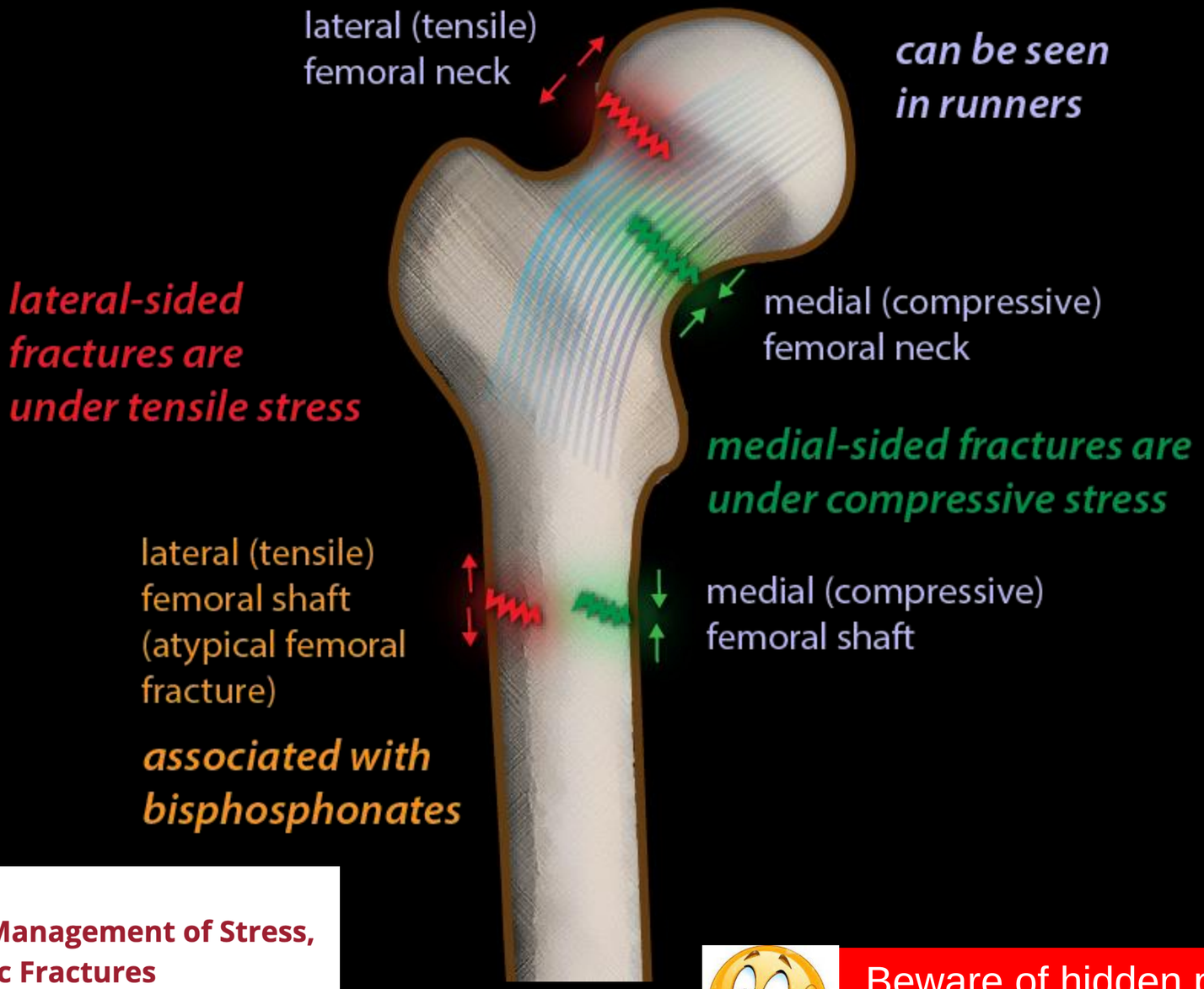


Trauma/Emergency Radiology

Imaging Features and Management of Stress, Atypical, and Pathologic Fractures

Richard A. Marshall, Jacob C. Mandell, Michael J. Weaver, Marco Ferrone, Aaron Sodickson, Bharti Khurana

Beware of hidden pathologies with fractures

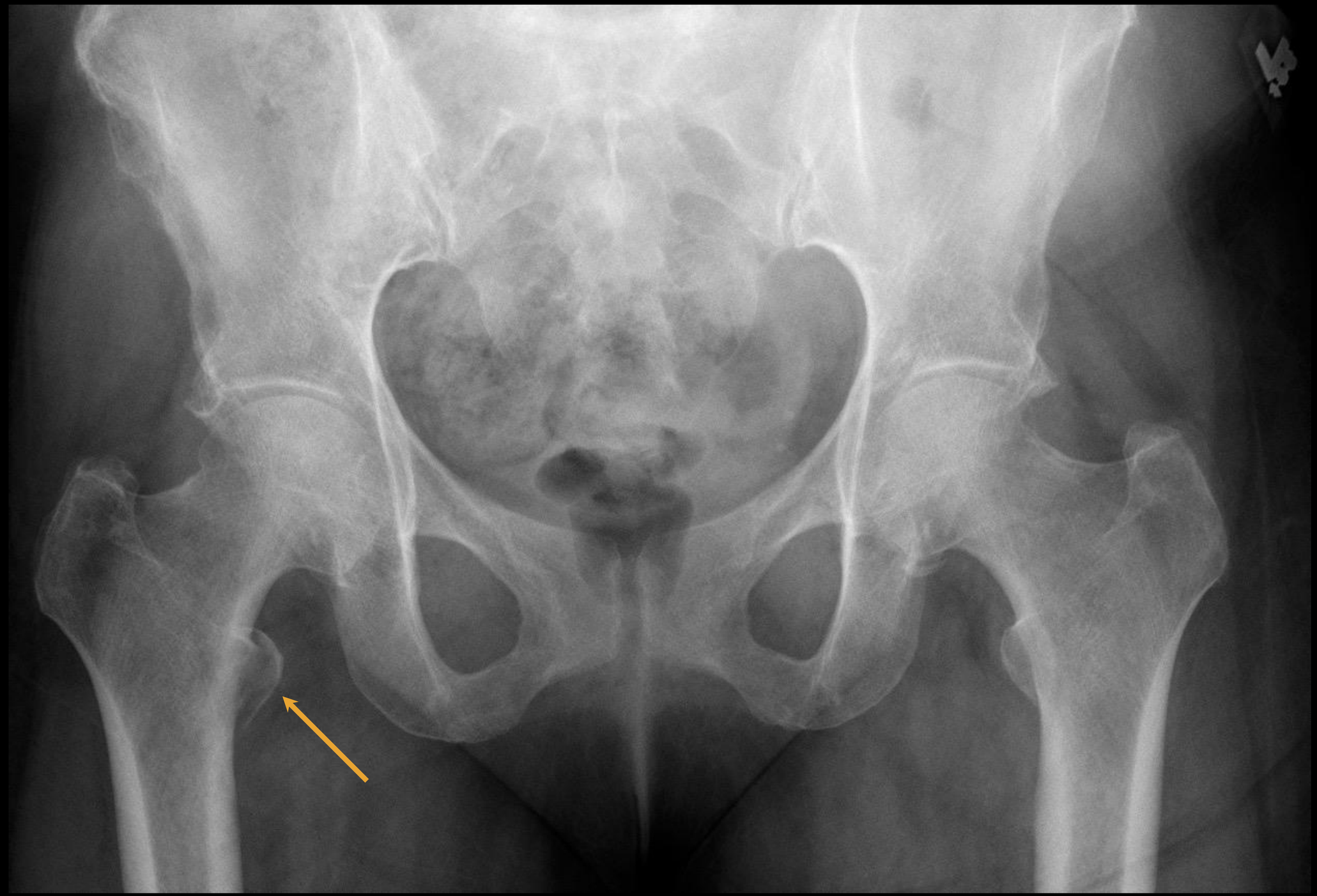
Paget’s disease

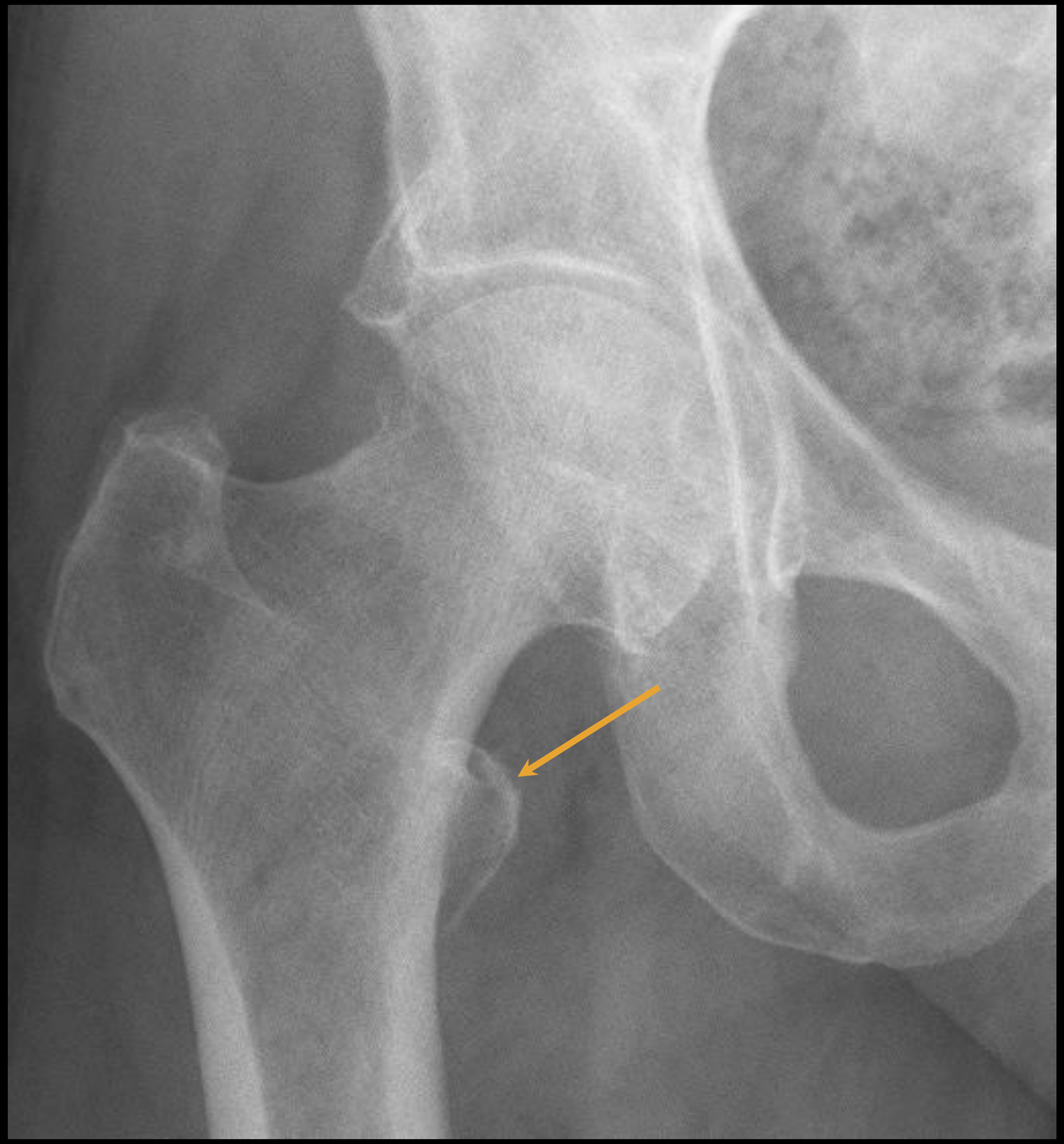
- **Enlargement, sclerosis, cortical thickening, trabecular prominence, deformity**
- **Atypical convex “banana” fracture**
- **Insufficiency fracture**

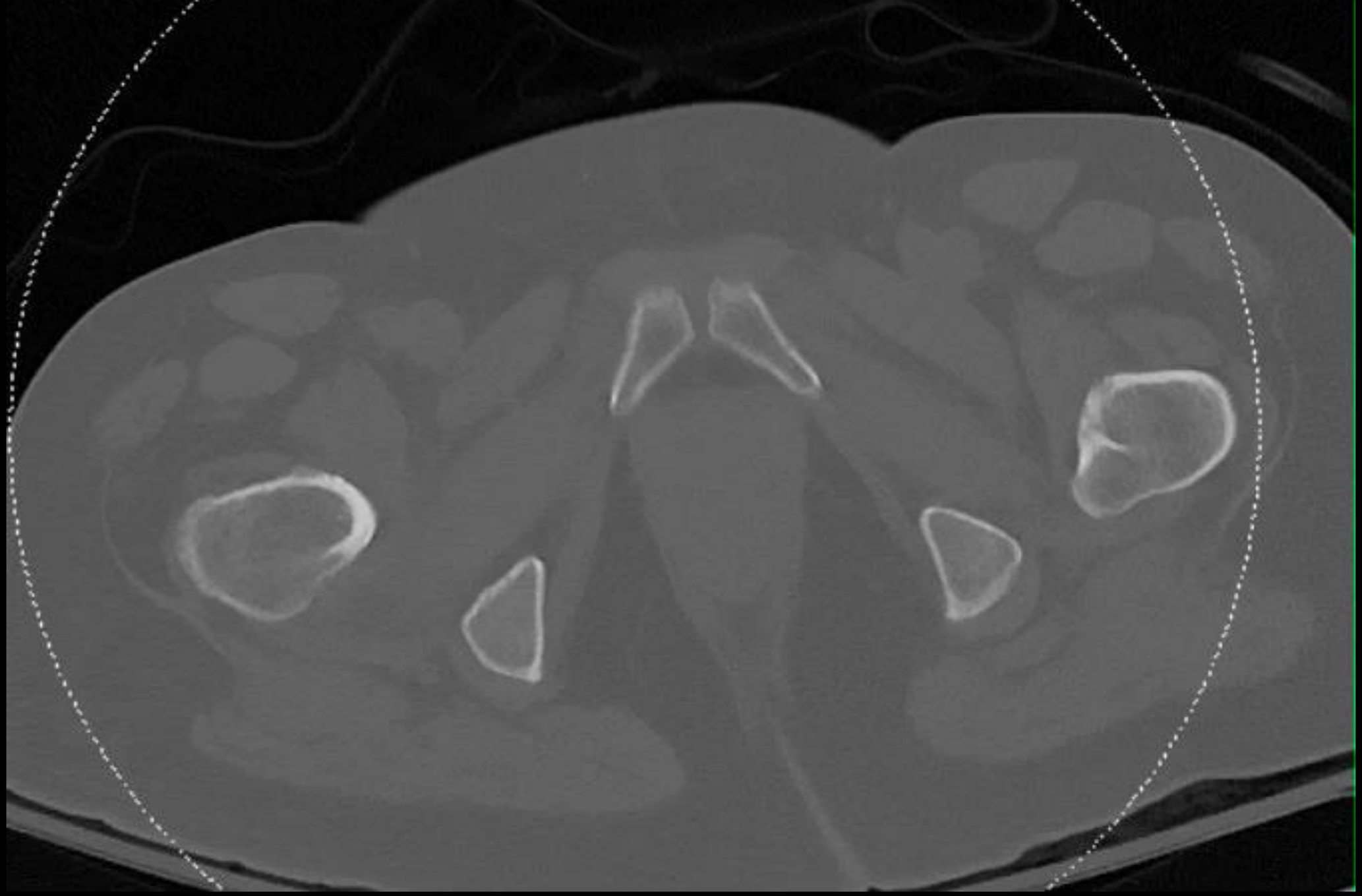
Some fractures are visible only when you understand the underlying pathology

Scenario

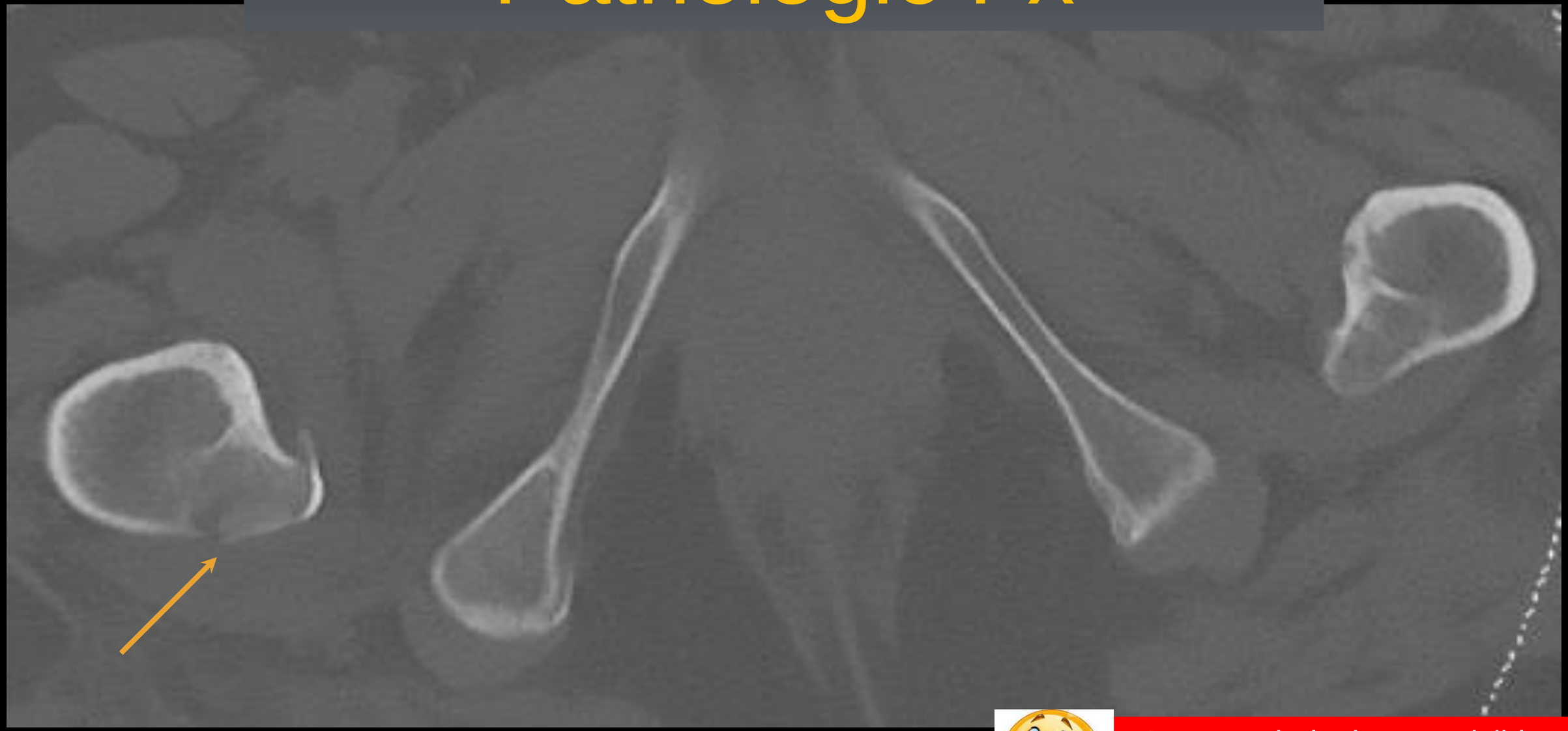
57-year-old woman acute right hip pain after a Yoga pose







Pathologic Fx



Some pathologies are visible only when you look for them


Melanoma


Prostate cancer metastasis

Pathologic Vs Stress Fx

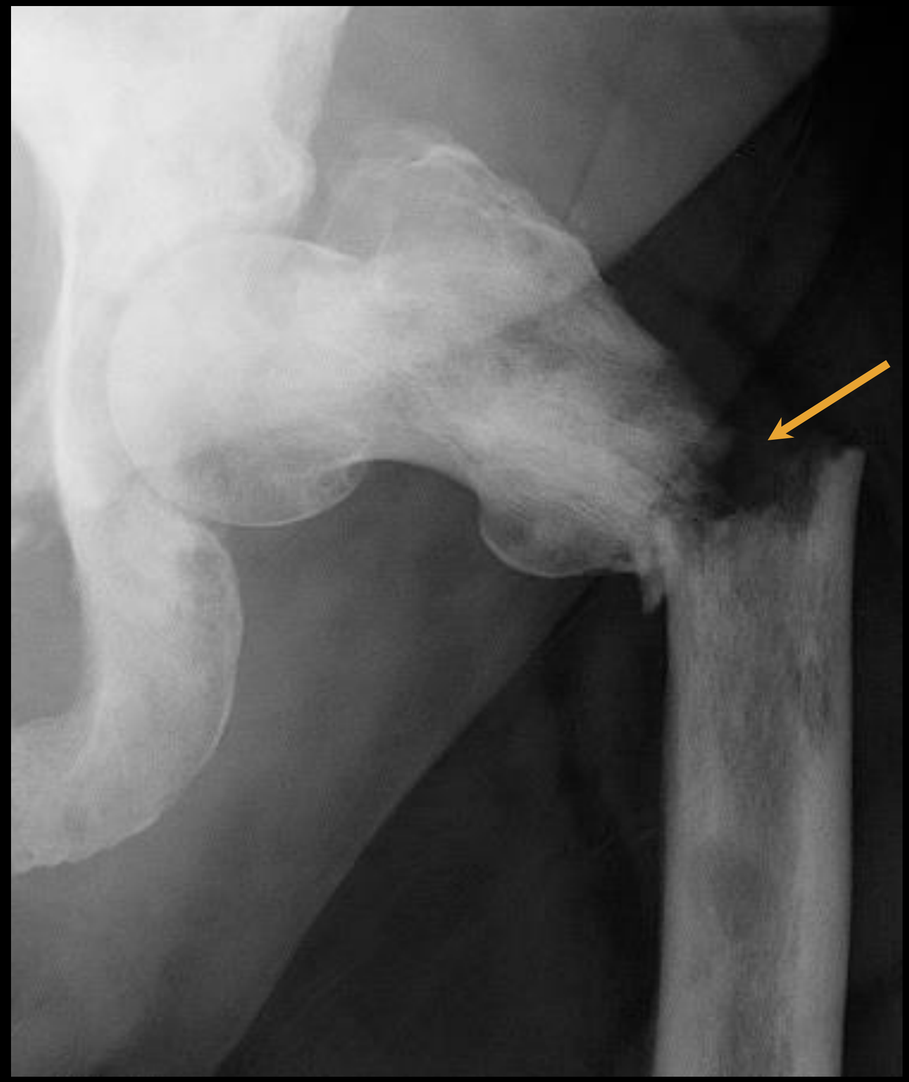
Pathologic Fx:

- Cortical destruction, endosteal scalloping
- Aggressive periosteal reaction
- Lytic, permeative pattern
- Absent or infiltrated fracture line
- Low T1 SI
- Substantial adjacent edema
- PET: Diffuse uptake

Stress Fracture

- Endosteal and Periosteal thickening
- Benign periosteal reaction
- Intact sclerotic trabecula
- Well-defined fracture line
- Heterogenous T1 SI
- Poorly defined muscle edema
- PET: Focal or linear uptake

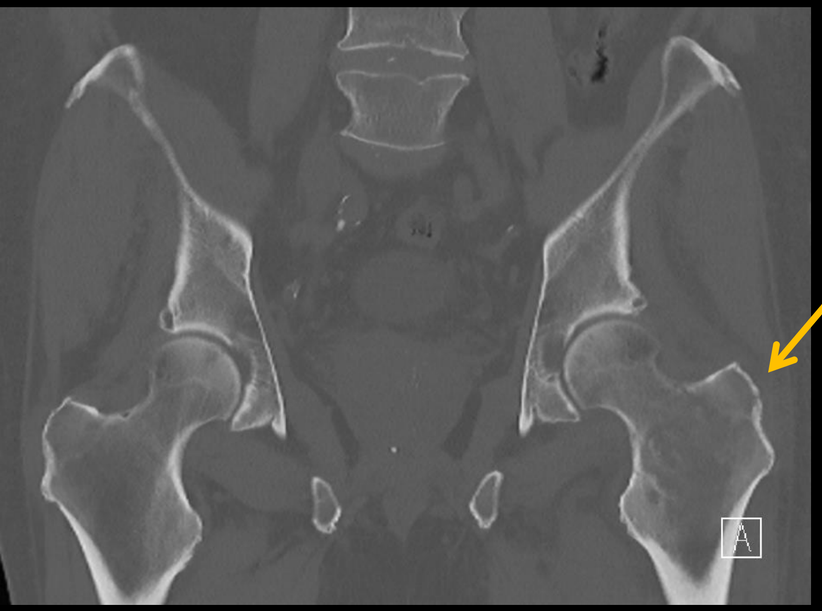
Pathologic Subtrochanteric Fx

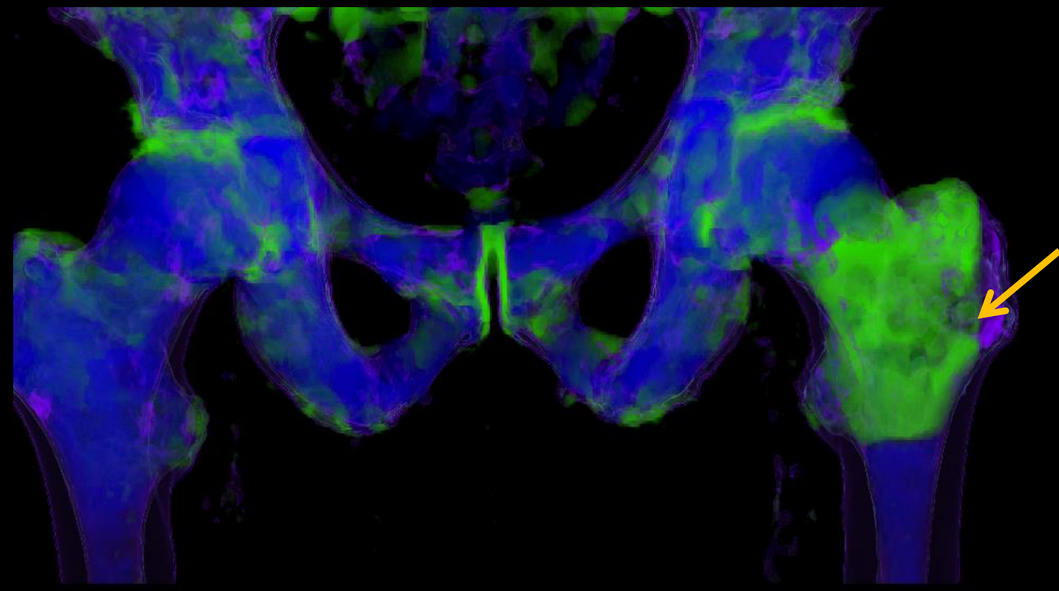


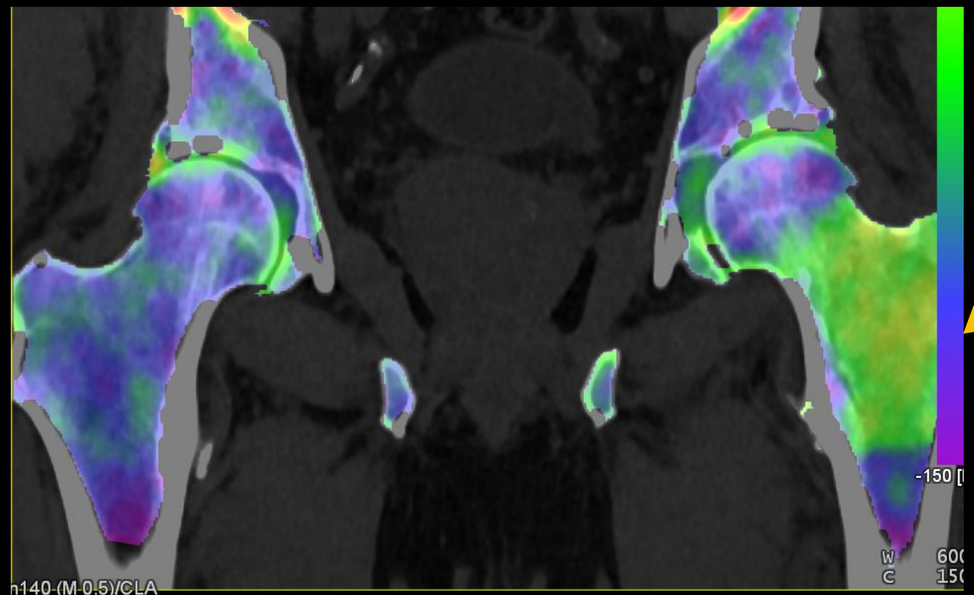
Scenario

64-year-old woman, status post fall
left hip pain

Non-Hodgkin’s Lymphoma







Predicting Fracture Risk: Mirels Criteria

Mirels Criteria

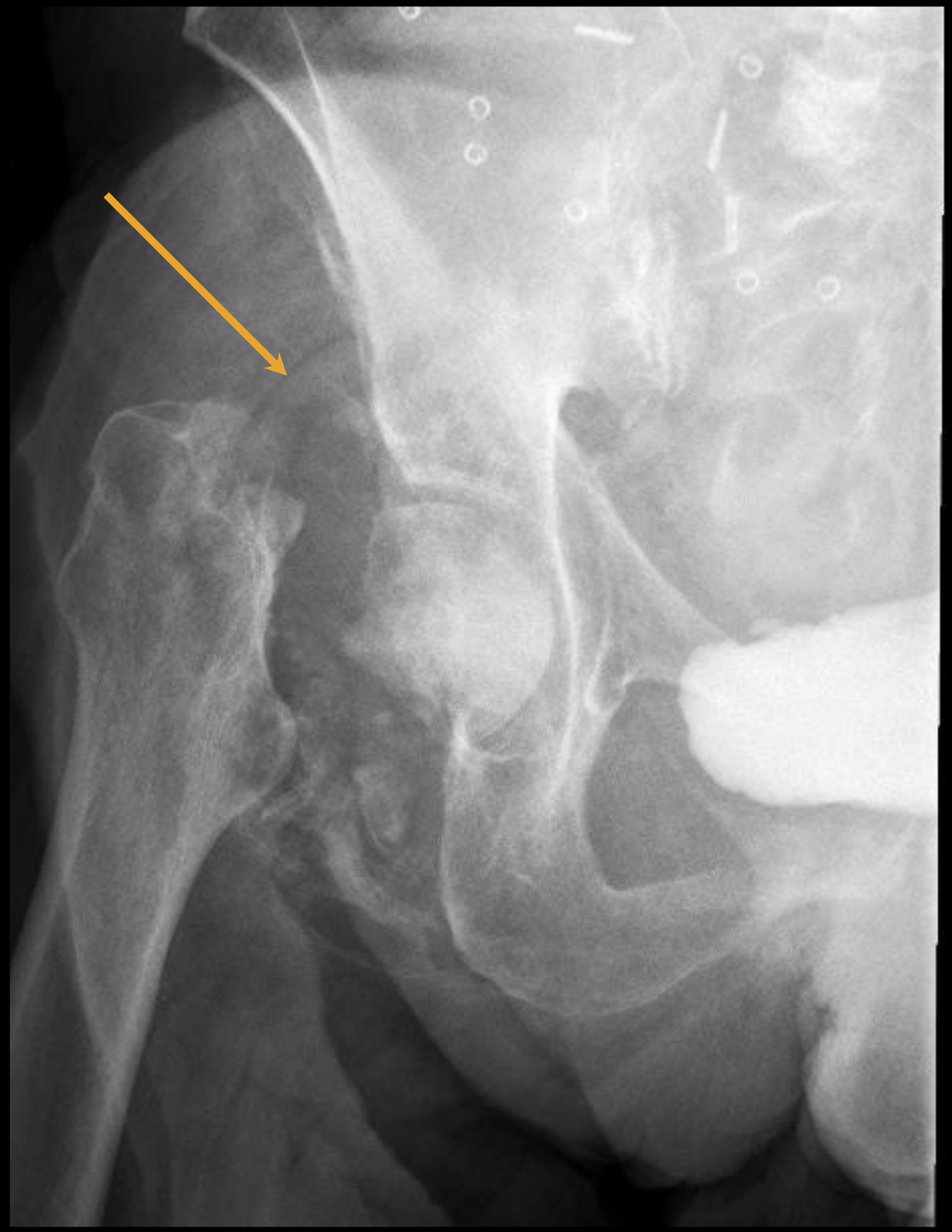
Score > 8-9 suggests need for prophylactic fixation

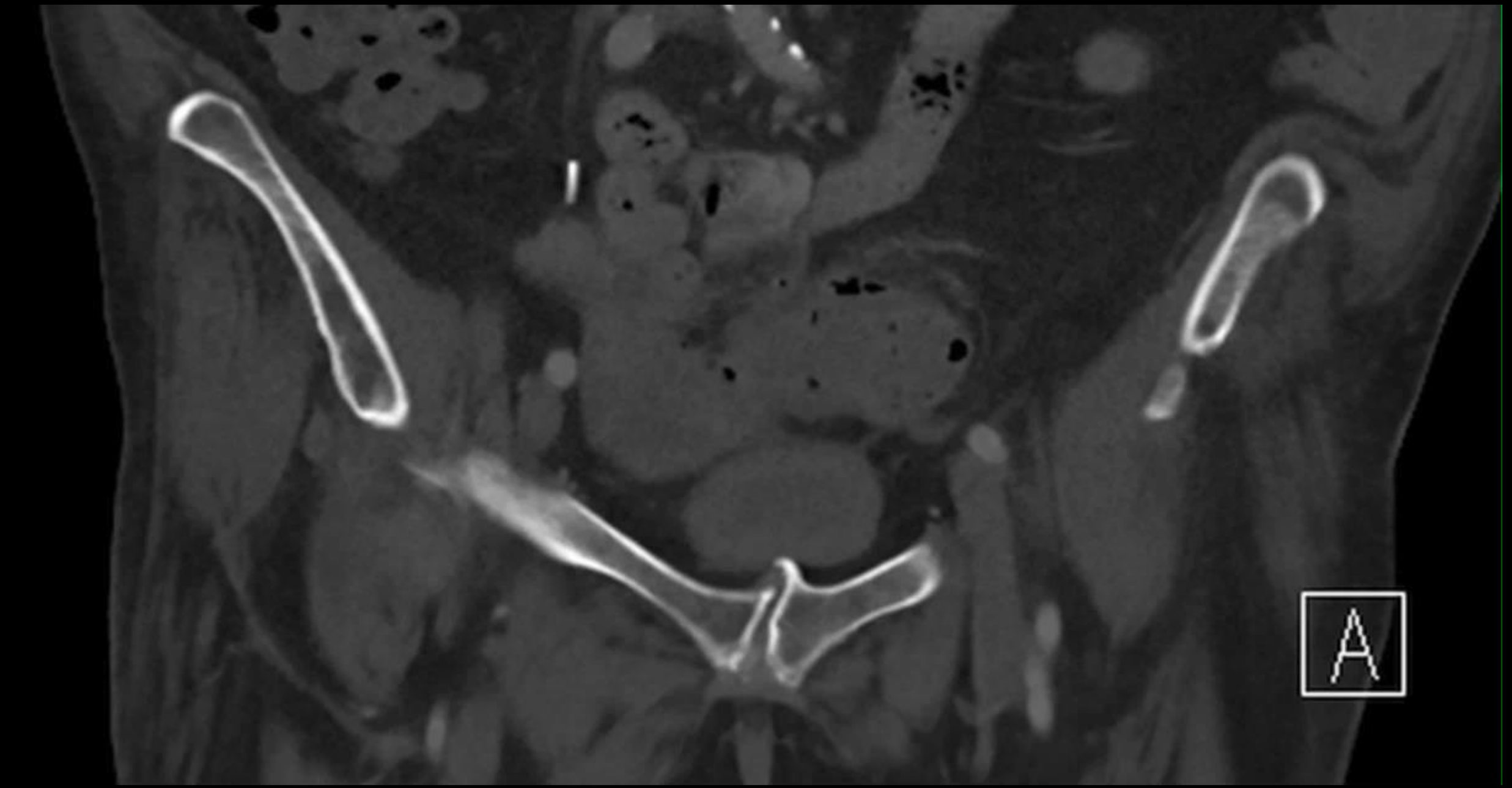
	Score		
Variable	1	2	3
Site	Upper Limb	Lower Limb	Peritrochanteric
Pain	Mild	Moderate	Severe
Lesion	Blastic	Mixed	Lytic
Size*	<1/3	1/3 - 2/3	>2/3

*Diameter of lesion with relation to bone

Scenario

90-year-old female, status post fall, acute right hip pain

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Scenario

29-year-old male, status post-fall

Segond Fx

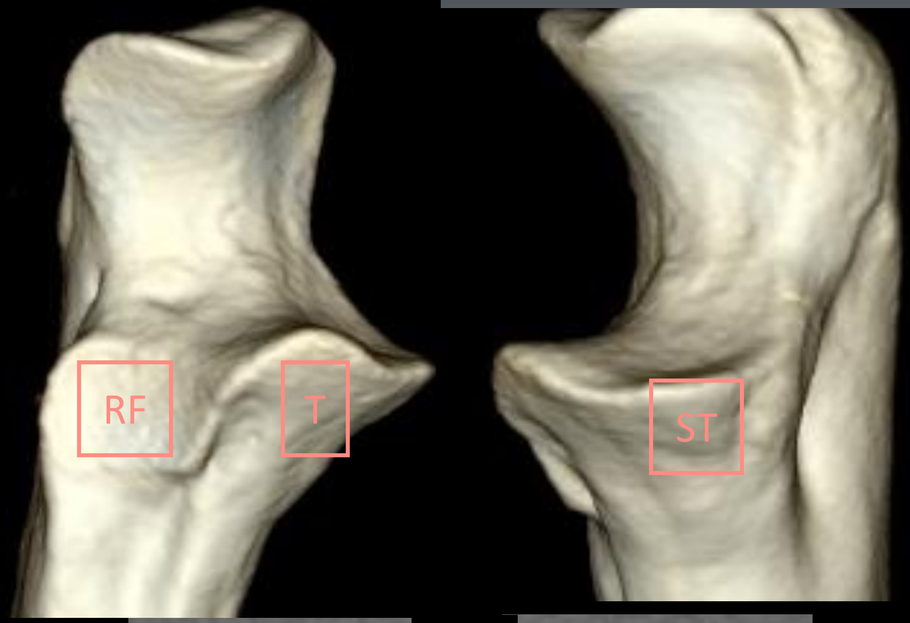
- Elliptical bone fragment parallel to the lateral aspect of the tibial plateau
- Lateral capsular sign
- ACL tear (75-100%)
- MM or LM tear (60-75%)
- LCL, Biceps avulsion
- No need to do a CT

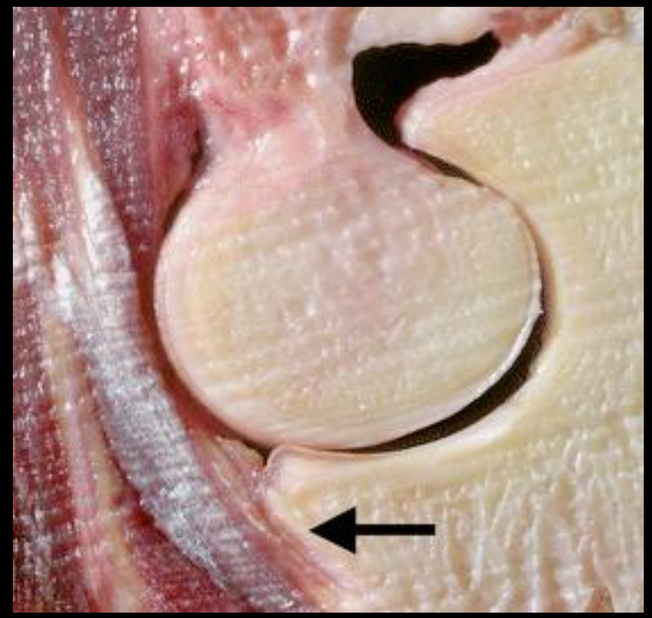
Scenario

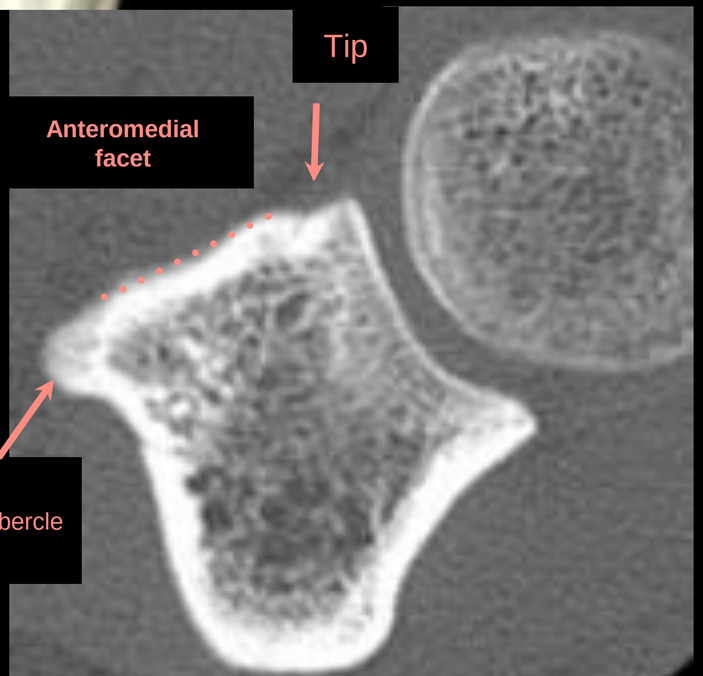
33-year-old female, status post fall

A subtle fracture can be the tip of the iceberg

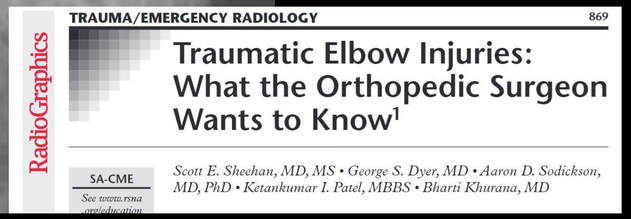
Coronoid Process of Ulna



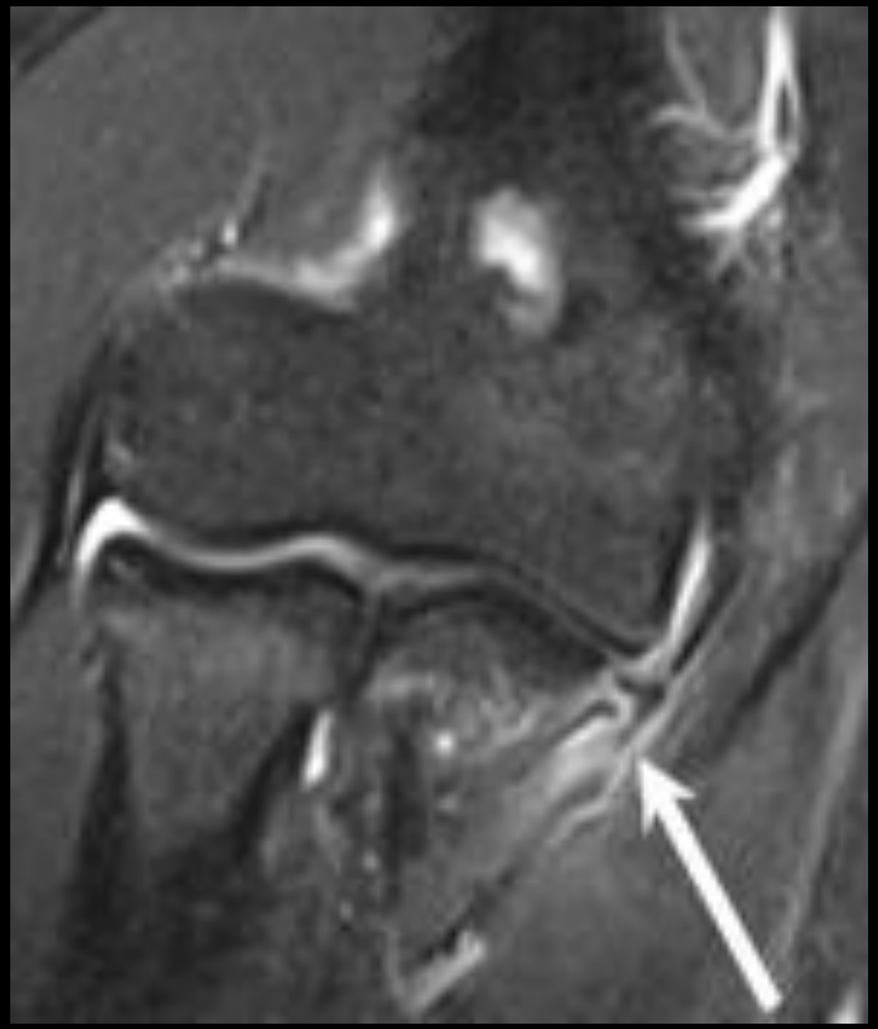




Double Crescent Sign



Sublime Tubercle Avulsion

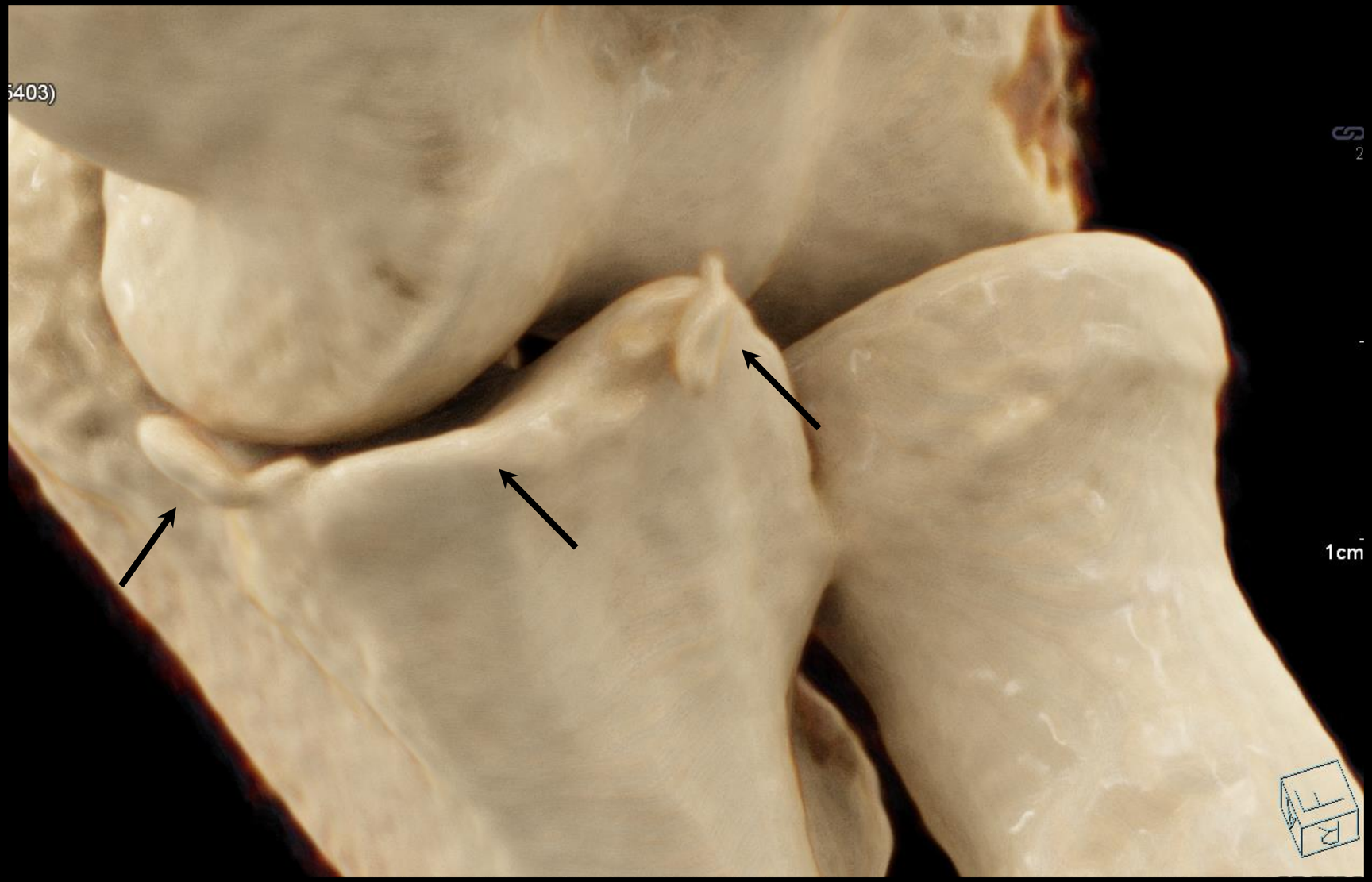


Coronal PD FS

Axial PD FS

A subtle fracture can be the tip of the iceberg

Sublime Tubercle Avulsion


5403)
1cm

Case

42-year-old woman with a history of fall


L
AS

Isolated Ulnar Fracture

FOX 25
WFXT · BOSTON

Isolated Ulnar Fracture

Does an isolated ulnar fracture in a woman represent IPV?

Can we differentiate an ulnar fracture due to IPV from accidental causes?

RECOGNIZING ISOLATED ULNAR FRACTURE AS A POTENTIAL MARKER FOR INTIMATE PARTNER VIOLENCE

Khurana B, Sing D, Gujrathi R, Keraliya A, Bay CP, Chen I, Seltzer SE, Boland GW, Harris MB, Dyer GSM, Tornetta P.

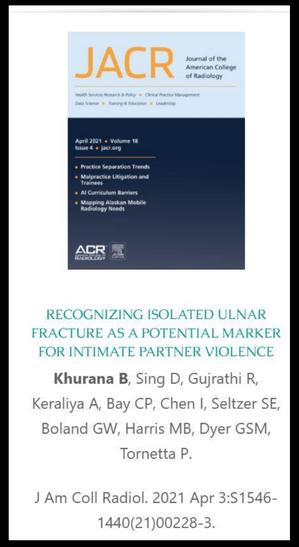
Isolated ulnar fracture as a potential marker for IPV

Three level 1 trauma centers-BWH, MGH, BMC
All women, 18-50 years with isolated ulnar fractures=62

26% of isolated ulnar fractures in women were attributable to IPV

- Confirmed IPV: 12
- Suspected IPV: 8

32% of women with isolated ulnar fractures were either confirmed or clinically suspected to have IPV



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J Am Coll Radiol. 2021 Apr 3:S1546-1440(21)00228-3.

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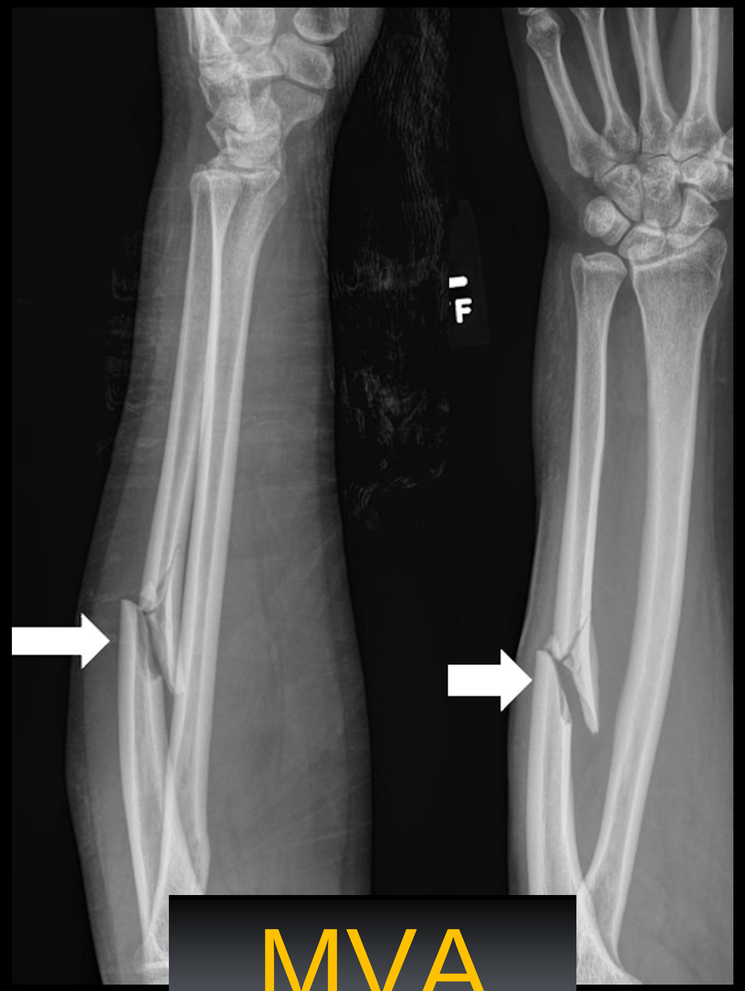
Ulnar fractures: IPV Vs Accidental Causes

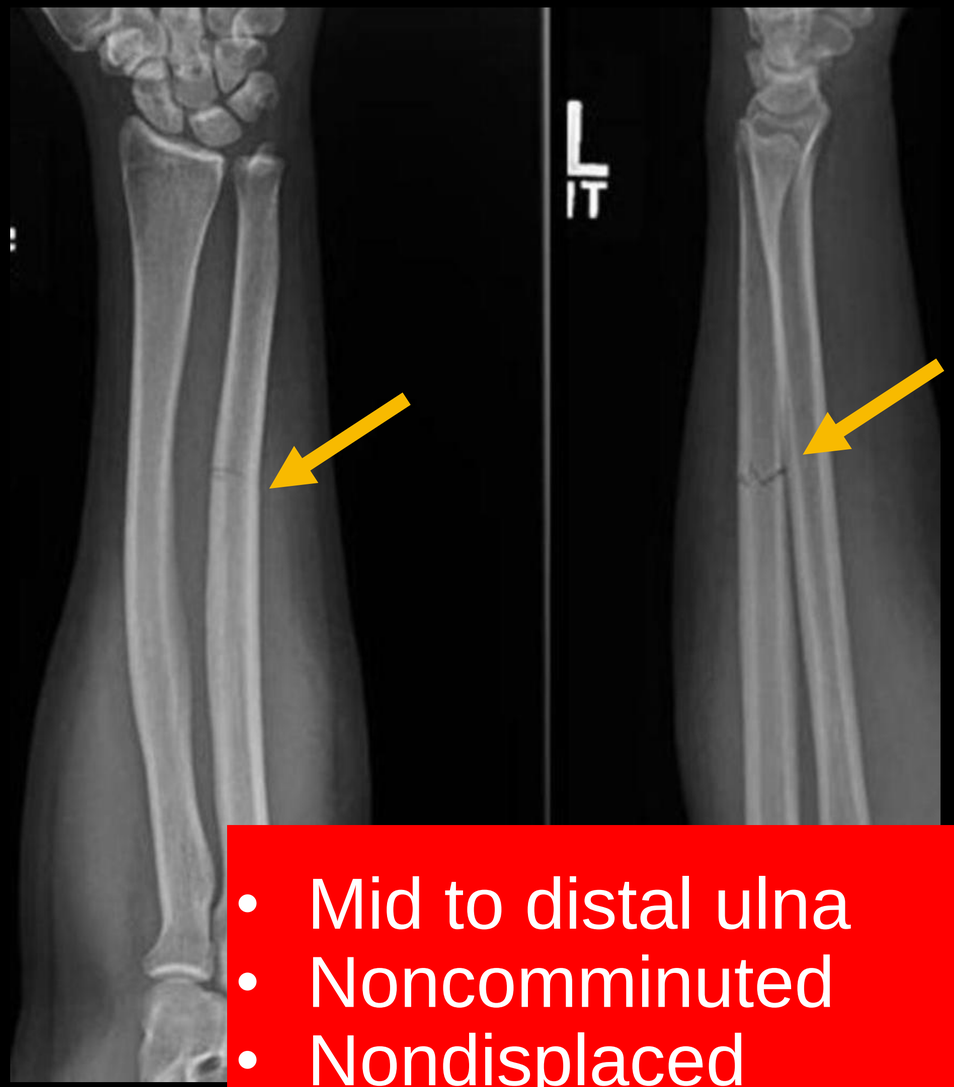
IPV

- Non-displaced (95% vs 43%; p<0.001)
- Transverse
- Non comminuted
- Mid to distal ulnar shaft



MVA

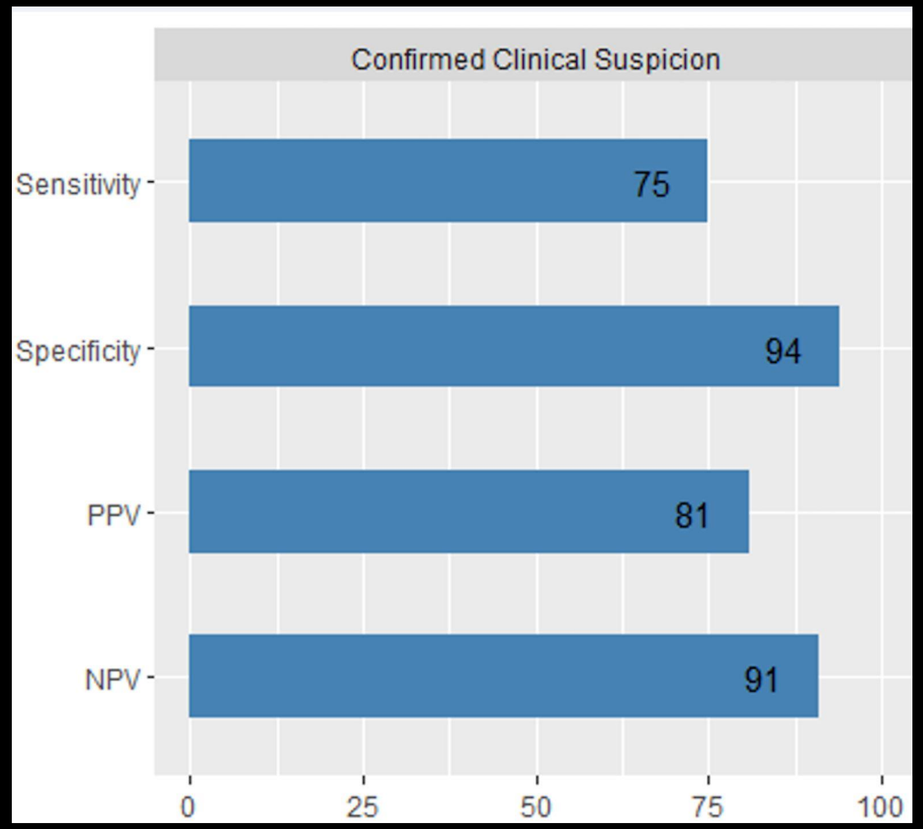
IPV Ulnar Fx

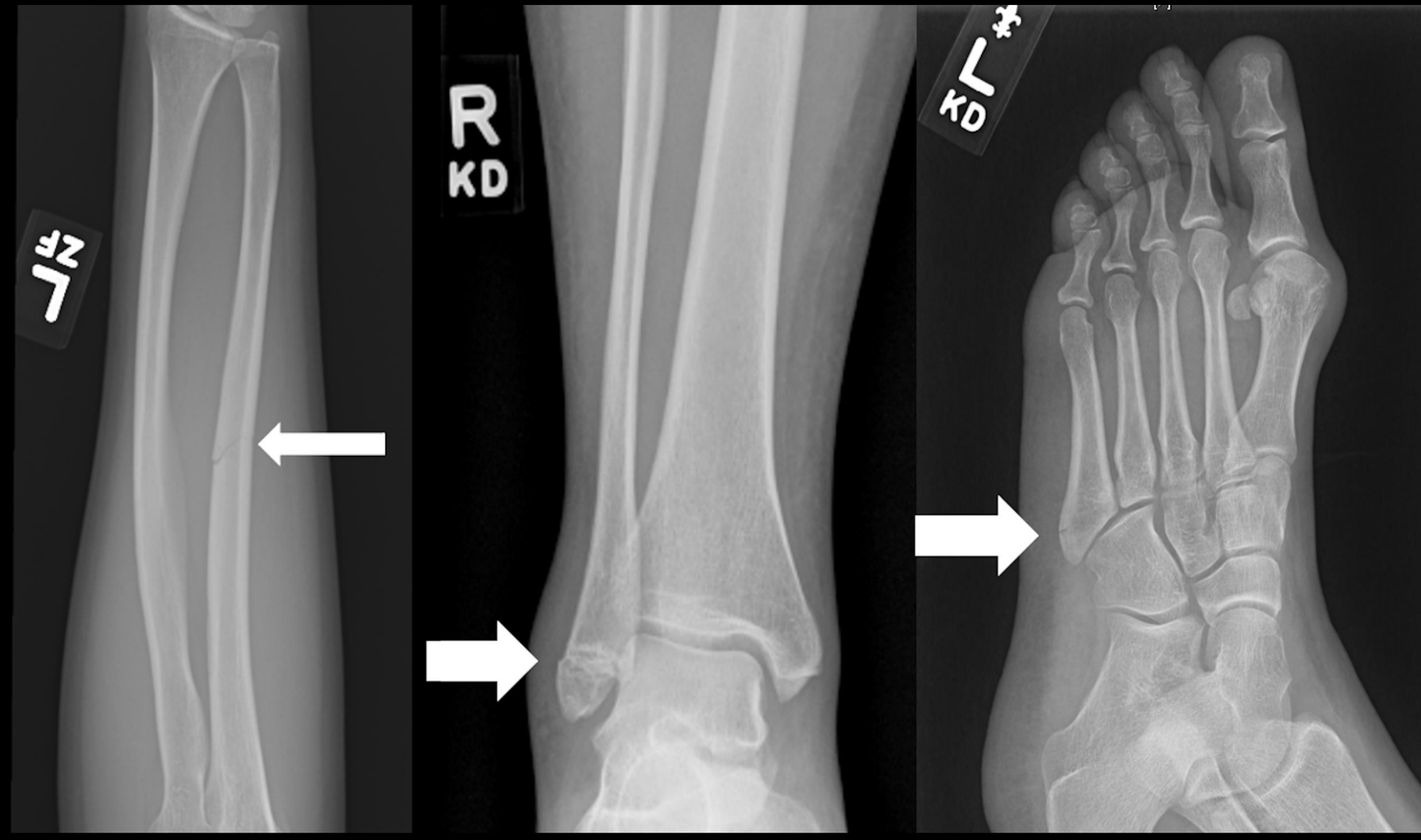


- Mid to distal ulna
- Noncomminuted
- Nondisplaced

Historical Imaging Analysis in IPV prediction

2 radiologists blinded to the IPV status predicted IPV based on all available radiology reports alone





RECOGNIZING ISOLATED ULNAR FRACTURE AS A POTENTIAL MARKER FOR INTIMATE PARTNER VIOLENCE

Khurana B, Sing D, Gujrathi R, Keraliya A, Bay CP, Chen I, Seltzer SE, Boland GW, Harris MB, Dyer GSM, Tornetta P.

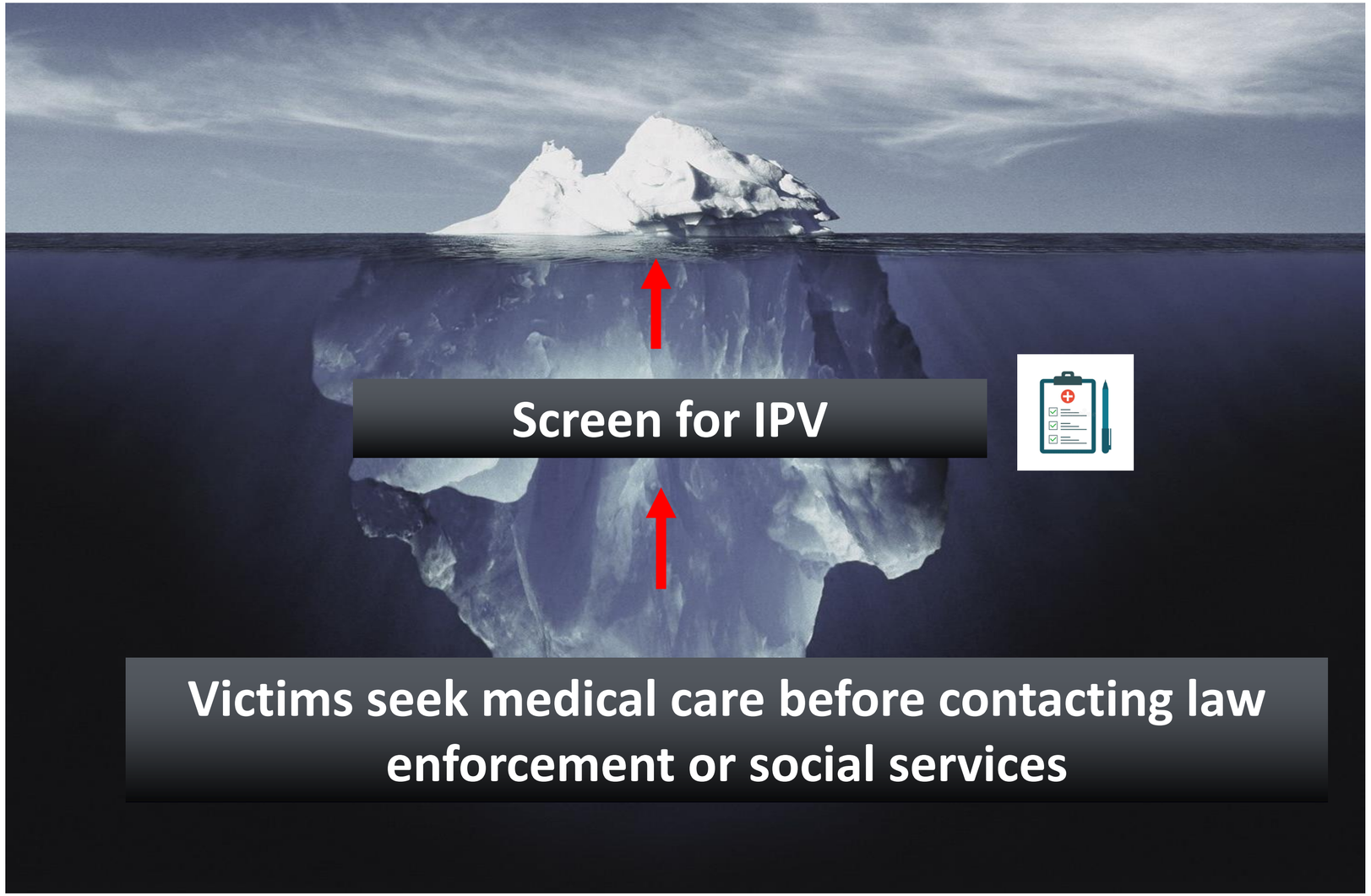
Problem: Intimate Partner Violence

Physical, Sexual or Emotional violence between current/former partners

>55% of female homicides are linked to IPV in the US

$3.6 trillion life-time economic cost for health care, lost productivity, and criminal justice in the US.

1 in 4 women and 1 in 7 men have reported IPV in their lifetime in the US



IPV: Patient and Provider Journey

PROVIDER

PATIENT

Lack of knowledge

Misconceptions

Time constrains

Regret and Frustration

Inactive Problem Recognition

Problem Minimization

Silent Awareness

Disclosure

Lack of Awareness

- Denial
- Self-blame
- Justification

- Social Stigma
- Social isolation
- Dependency

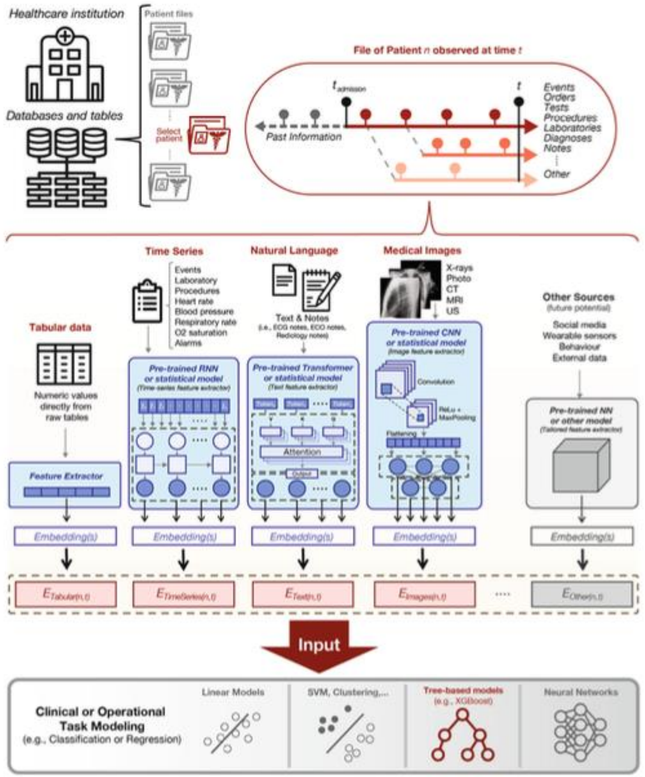
- Social worker referal
- Long-term adverse health effects
- Homicides, Suicides
- Intergenerational

- **Shelter, state aid, legal aid**
- **Burden on society, healthcare system, and government**
- **2/3 of Mass Shootings**

80% of IPV cases come through ED, yet only 5-30% are flagged

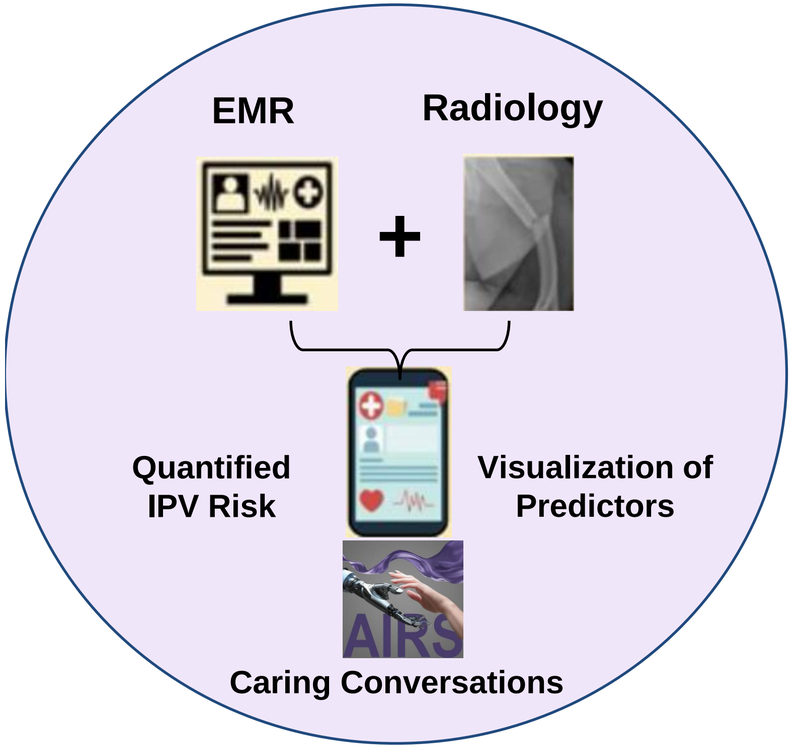
Solution: AIRS

Automated *Intimate Partner Violence* Risk Support (AIRS)



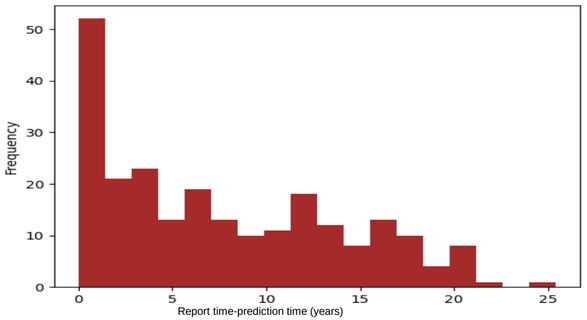
Prof Dimitris Bertsimas, MIT

Integrated multimodal artificial intelligence framework for healthcare applications. *npj Digit. Med.* **5**, 149 (2022)

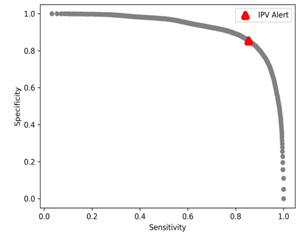


AUC Performance on Test Set (2013-2019)		
Tabular Model	Language Model	Tabular + Language Model
91%	90.1%	**92.6%**

AUC Performance on 2021		
Tabular Model	Language Model	Tabular + Language Model
84.9%	87.5%	**90.5%**



Mean: 6.51 years before self-report
Median: 4.66 years before self-report



Sensitivity: **85.4%**
Specificity: **85.3%**

Patient and Provider Journey with AIRS

Awareness

Problem Recognition

Support

Primary Prevention

- Understand their risk factors
- Learn healthy relationship skills
- Recognize unhealthy

Secondary Prevention

- Recognize the problem
- Resources and safety plan
- Self esteem and confidence

Tertiary Prevention

- Visual Evidence of Abuse
- Documentation for legal cases
- Health Risk Prediction & Prevention

Empowers providers and improves satisfaction

Automated **I**ntimate Partner Violence **R**isk **S**upport