

What the
rheumatologist is
looking for

What the radiologist
needs to know

Rheumatoid Arthritis

James Teh
Oxford



Introduction

- Novel therapies
 - Early diagnosis
 - Monitoring
-
- Understanding between rheumatologist and radiologist
 - Efficient, cost effective, individual needs, local resources

A word cloud on a black background featuring various radiology terms. The words are arranged in a circular pattern, with 'inflammation' and 'Erosions' being the most prominent. Other visible terms include 'marrow', 'Structural', 'Prognosis', 'Bone', 'Effusion', 'Synovitis', 'Oedema', 'lesions', 'Modality', 'Staging', 'Response', 'Active', 'Differential', 'Diagnosis', 'Imaging', 'steroids', and 'MRI'.

inflammation

Erosions

marrow

Structural

Prognosis

Bone

Effusion

Synovitis

Oedema

lesions

Modality

Staging

Response

Active

Differential

Diagnosis

Imaging

steroids

MRI

Teh and Ostergaard
Rad Clin NA 2017

What the rheumatologist is looking for

1. Is there inflammation?
 2. Are there structural changes?
 3. Are findings indicative of future structural damage?
- Which regions should be imaged?
 - Which modality?
 - Response?
-
- What is the differential diagnosis?

What the radiologist needs to know

Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

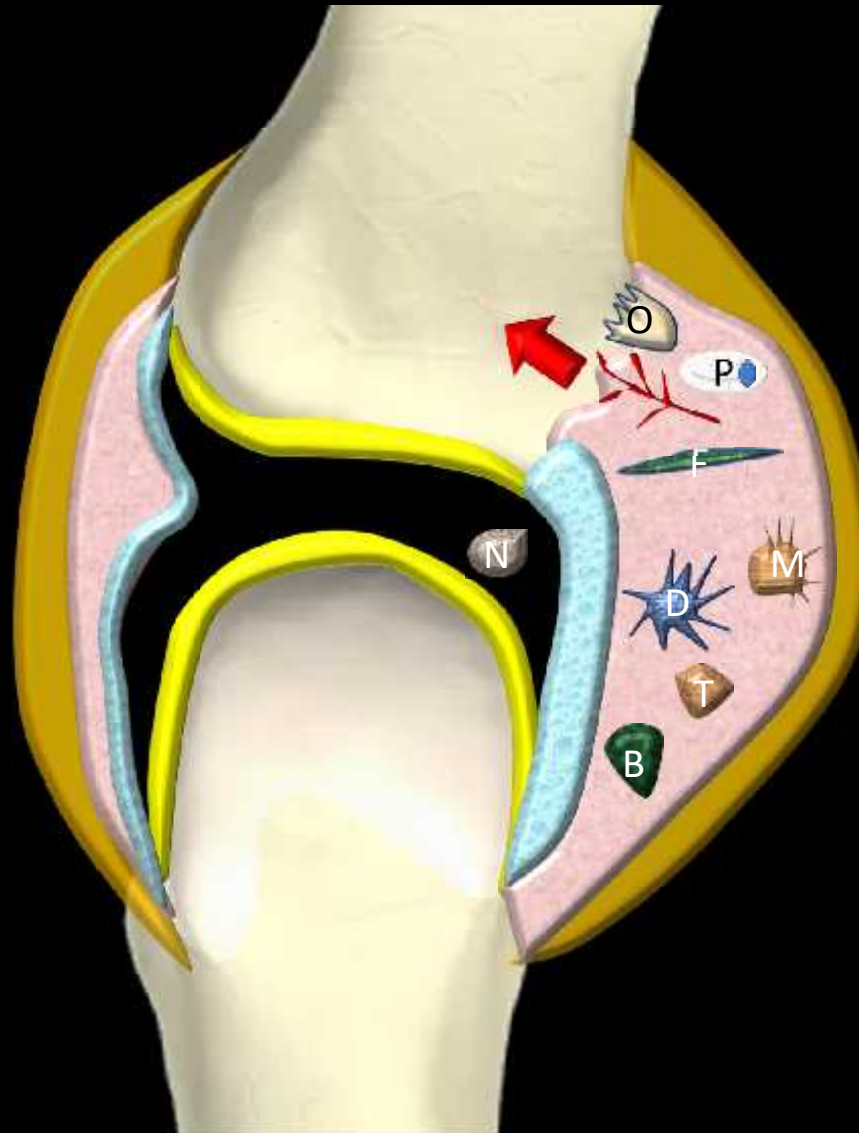
- Pathophysiology
- Features of inflammation
- Features of structural change
- Predictors of structural change
- Imaging modality
- Differential

Rheumatoid arthritis

Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

- Incidence 0.5-1%
- Polygenic disease
- Environment – Genetic – Autoantibody
- Anti citrullinated peptide antibodies (ACPA)
- Anti IgG antibodies (RF)
- Multi-system disease, predominant MSK manifestations

Pathology



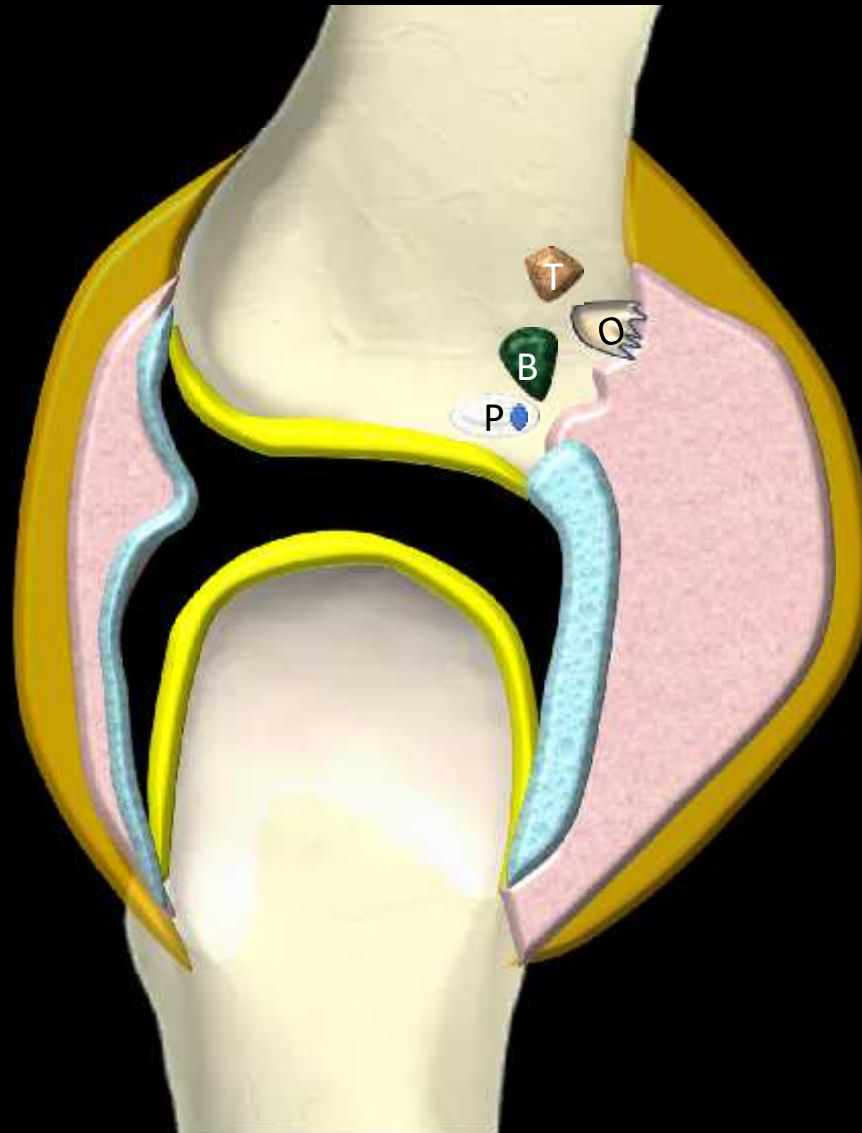
Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

Outside in
Classic theory
Synovitis first
Osteoclast activation

Fluid analysis
Sites of erosions

Schett and Firestein
Ann Rheum Dis 2010

Pathology



Inside out

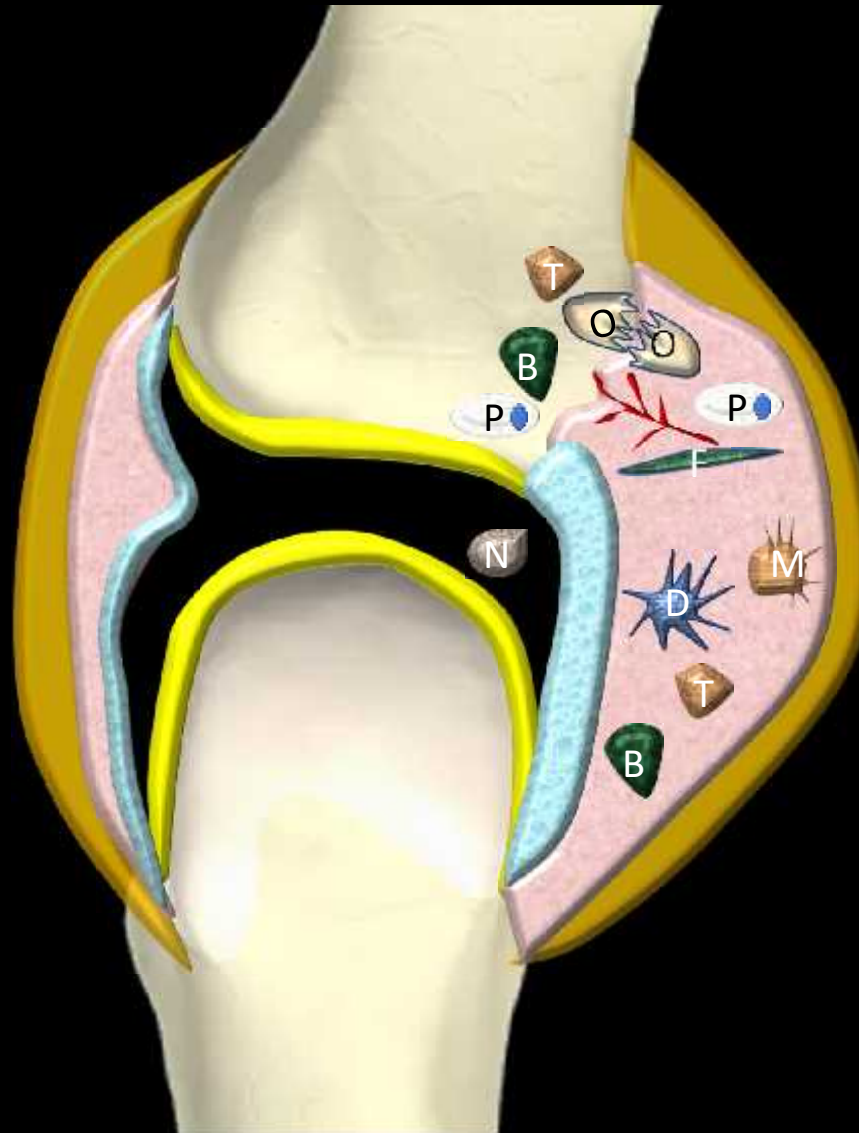
Osteitis first

Osteoclast activation

MRI bone marrow change

Histology

Pathology



Both!

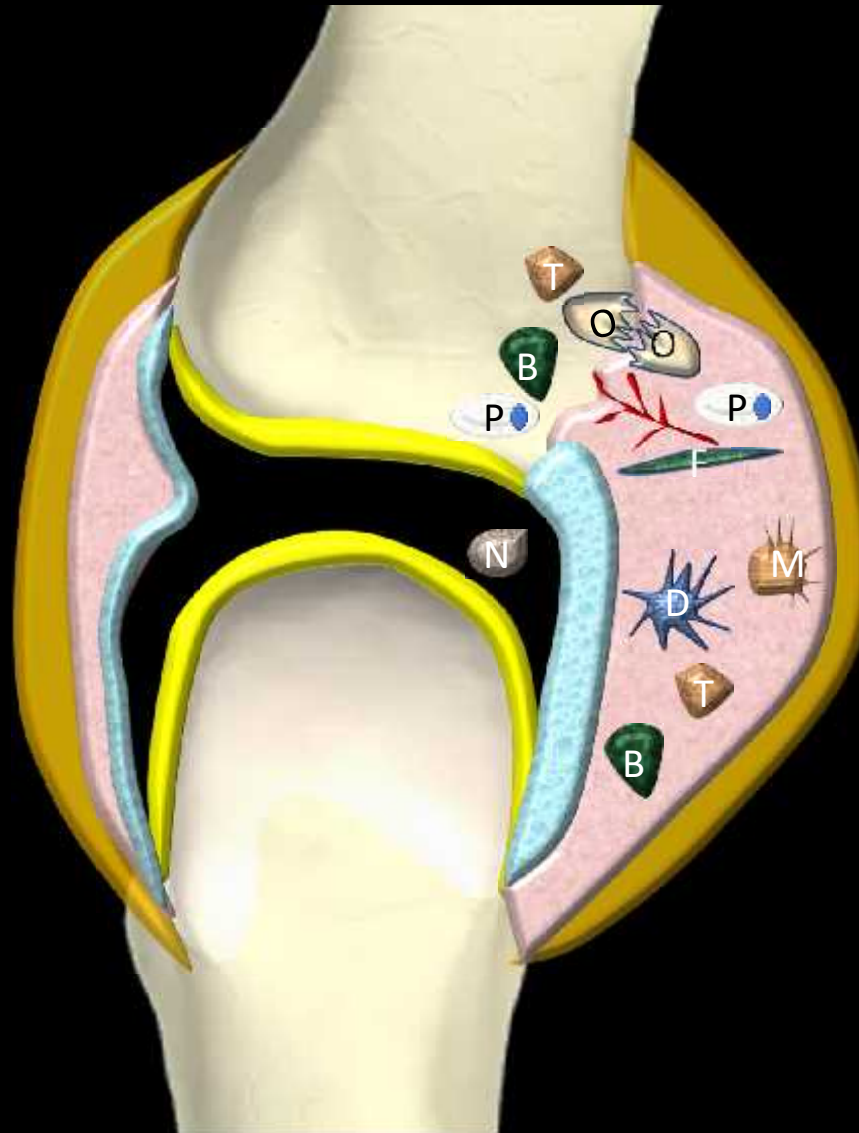
Outside-in

Inside-out

Synovitis

Osteitis

Imaging



Features

Effusion

Synovitis

Bone marrow oedema

Erosions

Inflammation

Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

Is there inflammation?

Rheumatologist

Is there inflammation?

Radiologist

Effusion

Synovitis

Bone marrow oedema

Tenosynovitis

Bursitis

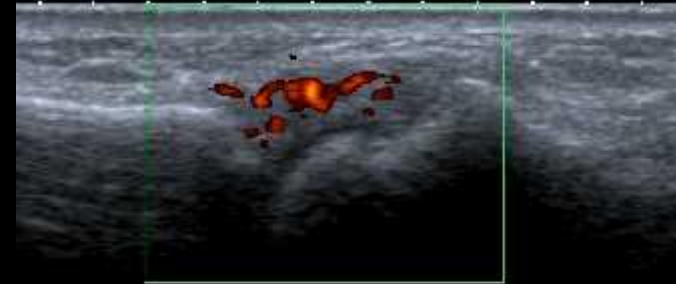
Which imaging modality?

Which modality?

X-rays

MRI

Ultrasound



X-ray

Rheumatoid nodule

Ulnar deviation
Subluxations
Erosions
Peri-articular osteopaenia

Inter-carpal collapse



~~X-ray~~



Early detection of synovitis

	US	MRI
Synovitis	+++	+++
Delineation	++	+++
Coverage	++	++
Predictive	++	+++
Availability	+++	+

US and MRI better than clinical examination for synovitis

Backhaus et al, Arthritis Rheum 1999;42(6)

Conaghan et al, Ann Rheum Dis 1999;28

Power Doppler comparable to MRI for synovitis

Szkudlarek et al, Arthritis Rheum. 2001 Sep;44(9)

MRI

Bone

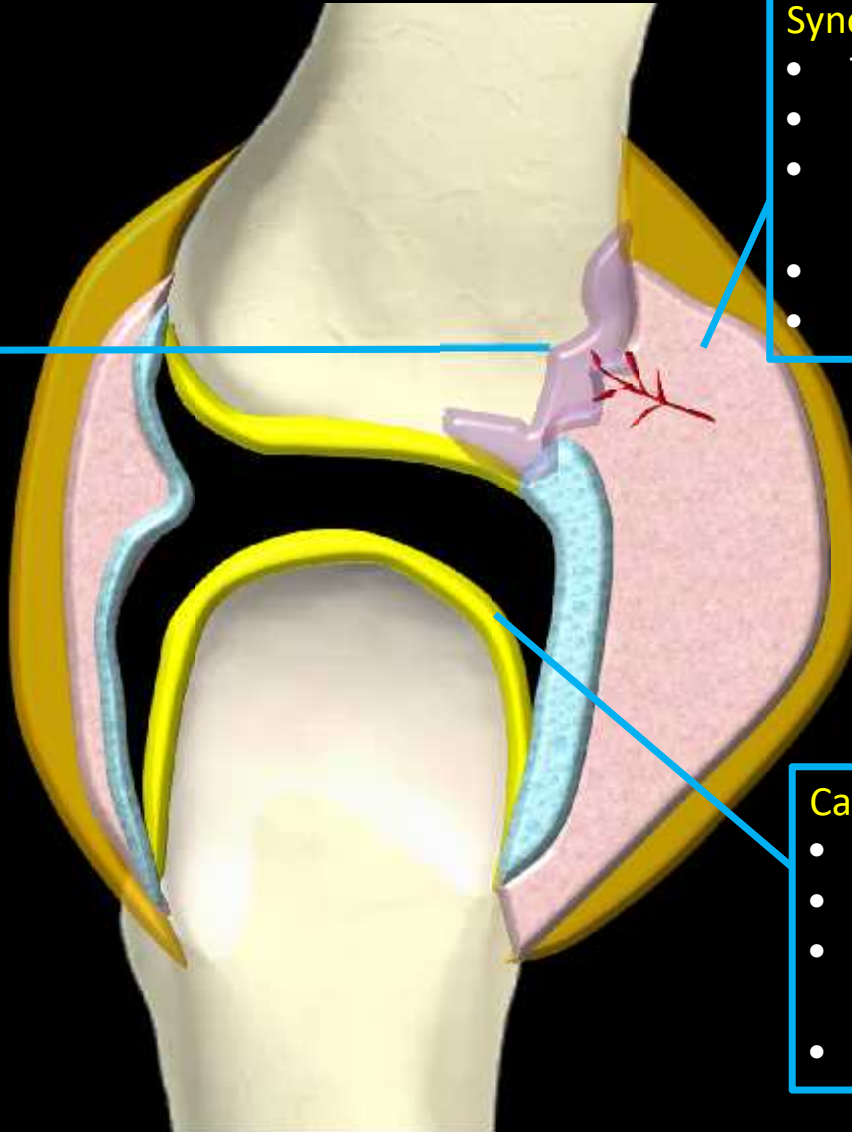
- T1w - erosions
- T1w + Gd
- Fluid sensitive - bone oedema

Synovium

- T2w – fluid
- Fluid sensitive – STIR, T2fs
- Dynamic contrast enhanced DCE
- Diffusion tensor imaging DTI
- Diffusion Kurtosis

Cartilage

- T2 mapping
- dGEMRIC
- ^{27}Na - proteoglycan depletion
- T1p imaging



Sequences

OMERACT

Outcome measures in rheumatology clinical trials

EULAR

European Alliance of Associations for Rheumatology

ESSR

Arthritis subcommittee

Recommendations of the ESSR Arthritis Subcommittee for the Use of Magnetic Resonance Imaging in Musculoskeletal Rheumatic Diseases

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Claudia Schueller-Weiderkamm, MD³⁰

Semin Musculoskelet Radiol
2015;19:396

Sequences

- Coronal and Axial T1 pre and post Gadolinium
- T2 fs or STIR
- Isotropic 3D imaging

But in clinical practice

- Coronal T1 and STIR
- Axial T1 and T2fs
- 3T preferred
- Small FOV
- Thin section <3mm

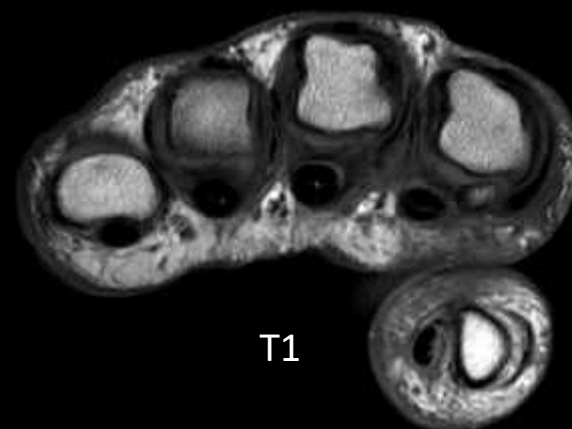




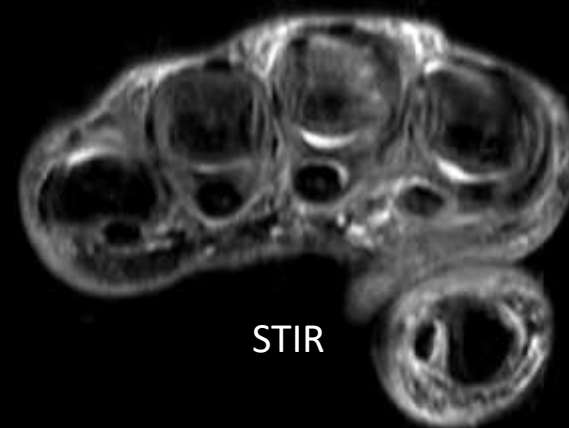
T1



STIR



T1



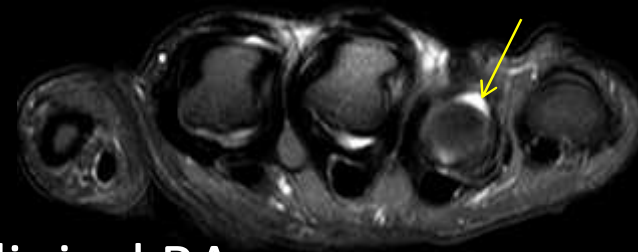
STIR

Early diagnosis

Imaging can help confirm subclinical RA

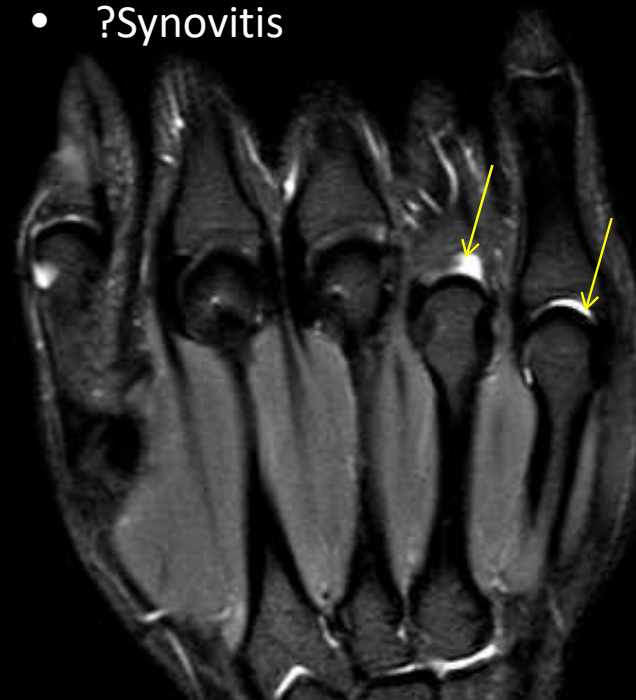
T1w

- ?Erosions



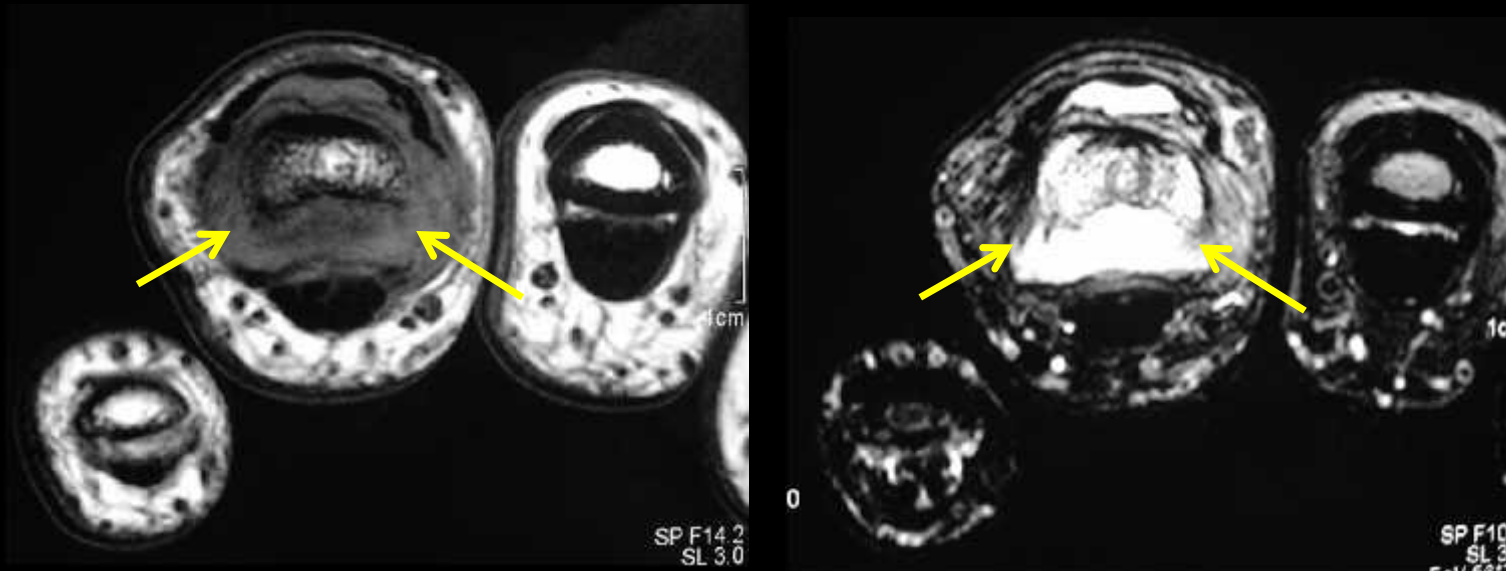
STIR

- ?Effusion
- ?Synovitis



Synovitis

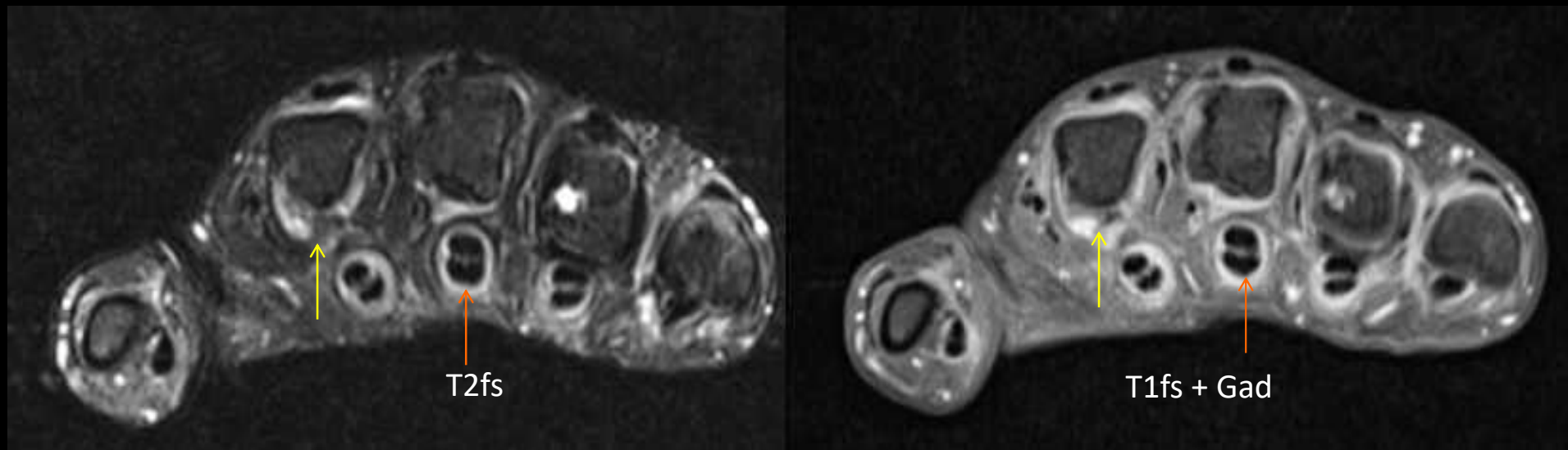
Synovitis. An area in the synovial compartment that shows above normal post-gadolinium enhancement of a thickness greater than normal synovium.



Yao et al
Peri-articular bone findings in RA
AJR Am J Roentgenol. 2006 Aug;187(2):358-63

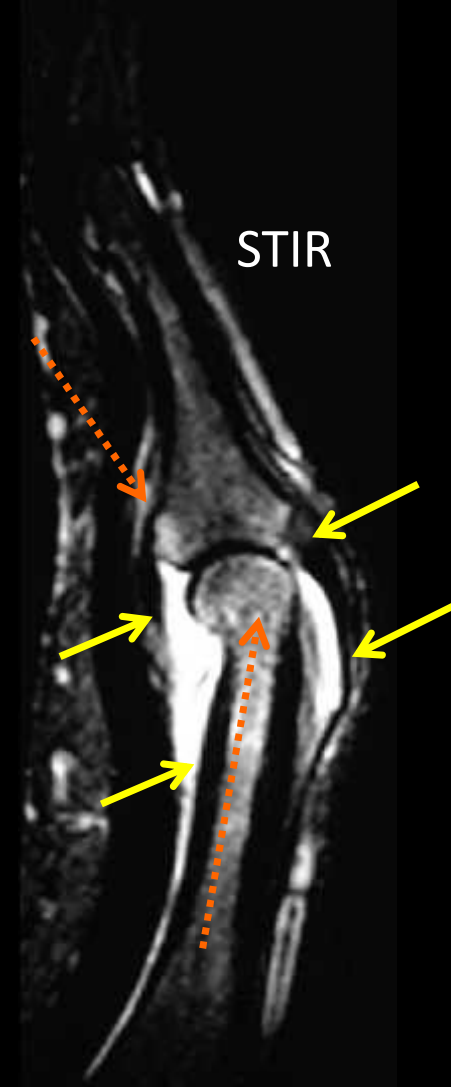
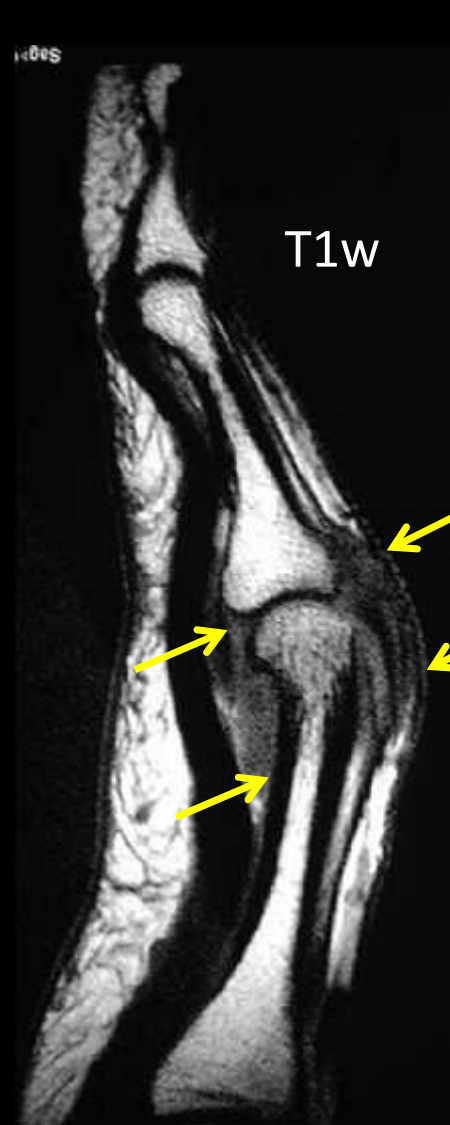
Synovitis

- Gadolinium allows differentiation of fluid from synovial hypertrophy
- Early post-contrast imaging only
- Eventually Gd diffuses into synovial fluid

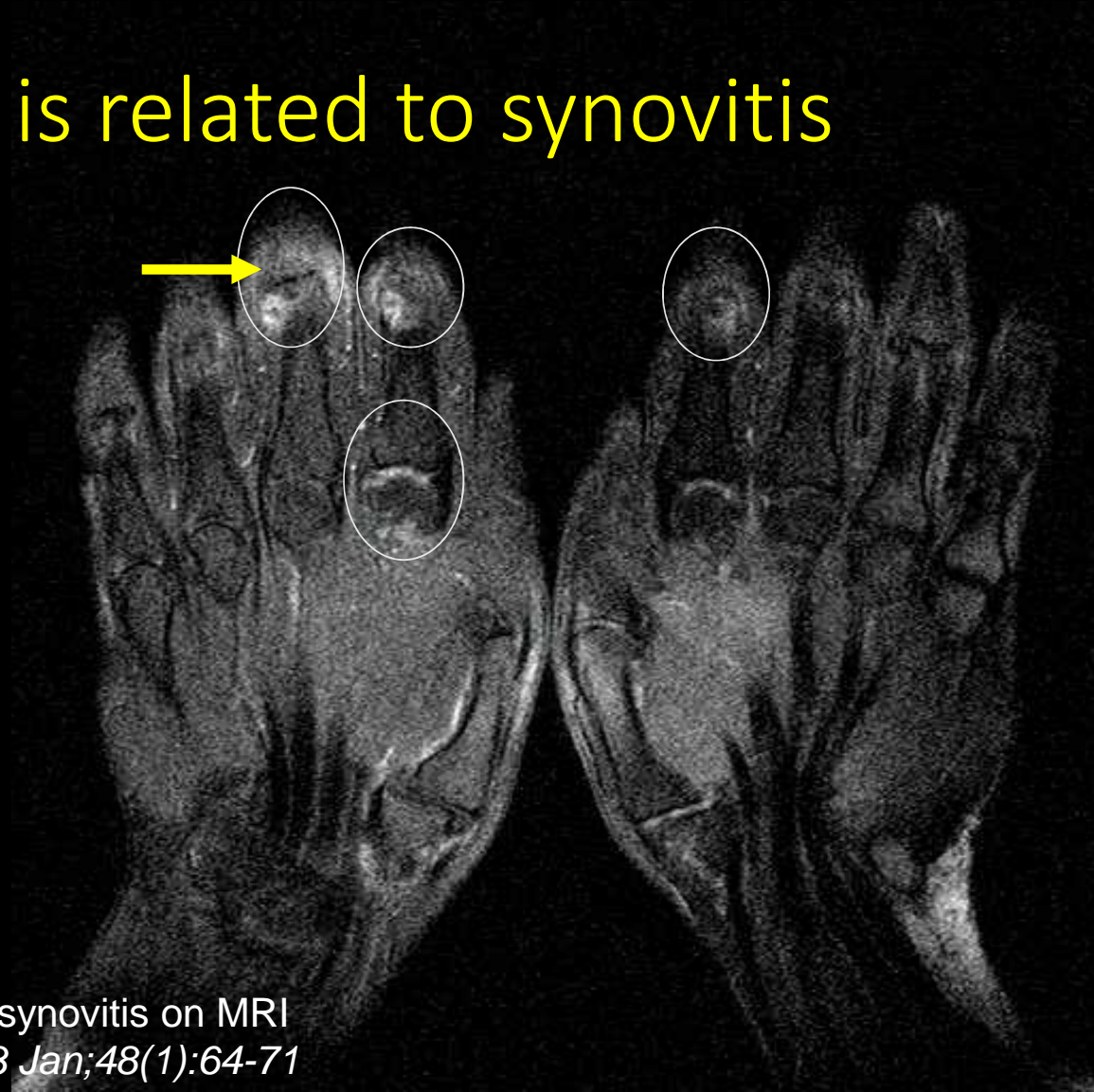


Szkudlarek *Arthritis Rheum* 2001 Sep;44(9):2018-23 - Compared Doppler US with dynamic MRI

Pre-radiographic

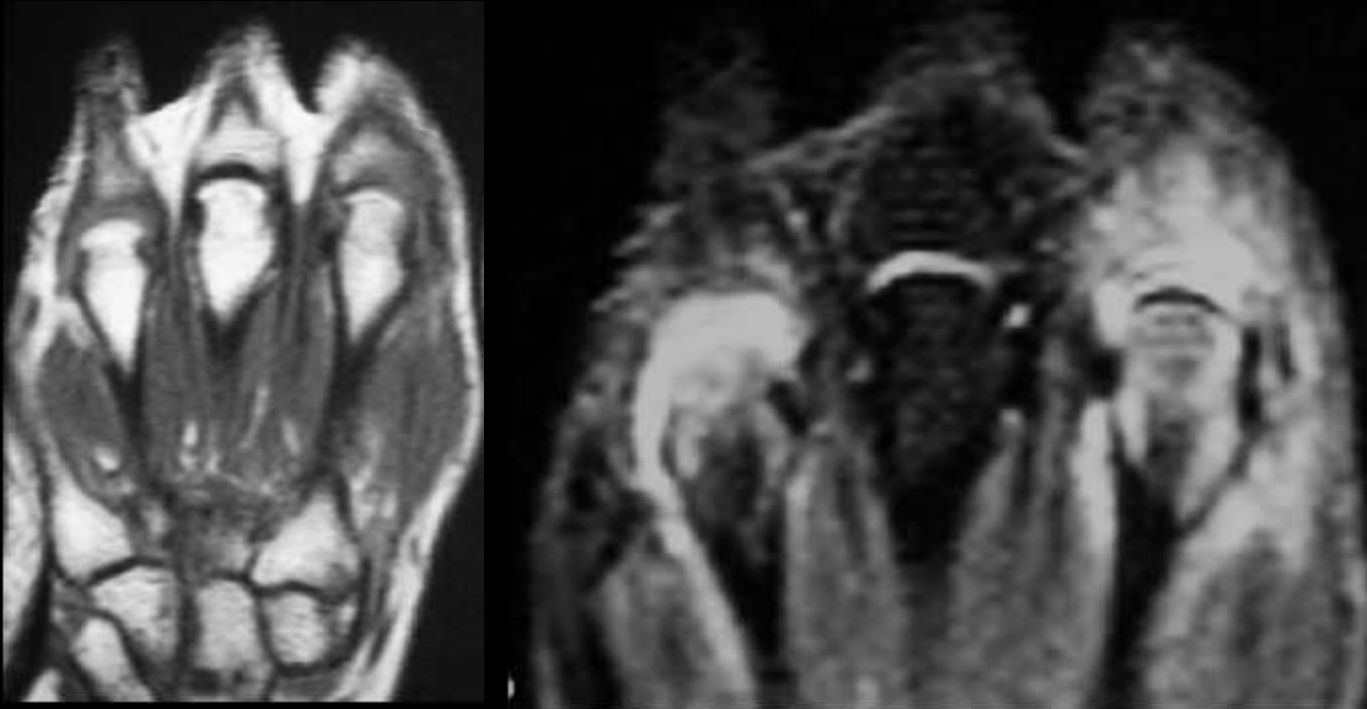


Bone damage is related to synovitis



Bone damage is related to degree of synovitis on MRI
Conaghan et al Arthritis Rheum. 2003 Jan;48(1):64-71

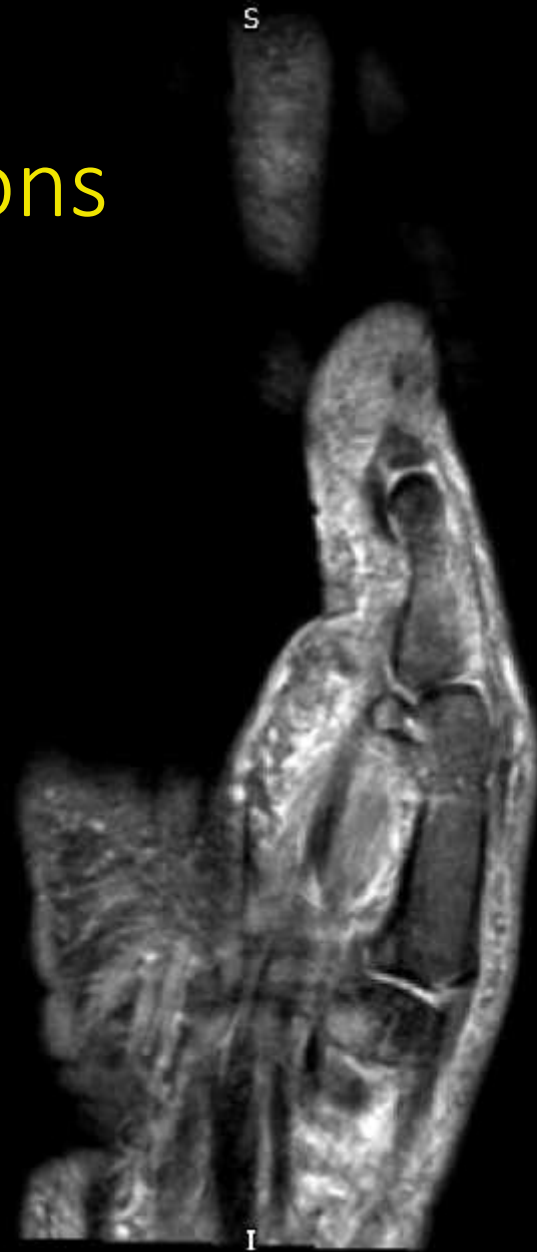
Bone damage is related to synovitis



In the treatment of patients with RA, outcome measures and therapies should focus on synovitis.

Bone oedema predicts erosions

McQueen FM et al
Bone oedema on MRI predicts radiographic joint damage 6 yrs later
Arthritis Rheum. 2003 Jul;48(7):1814-27.



Learning points

- Synovitis predicts erosions
- BME predicts erosions



Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

US

Bone

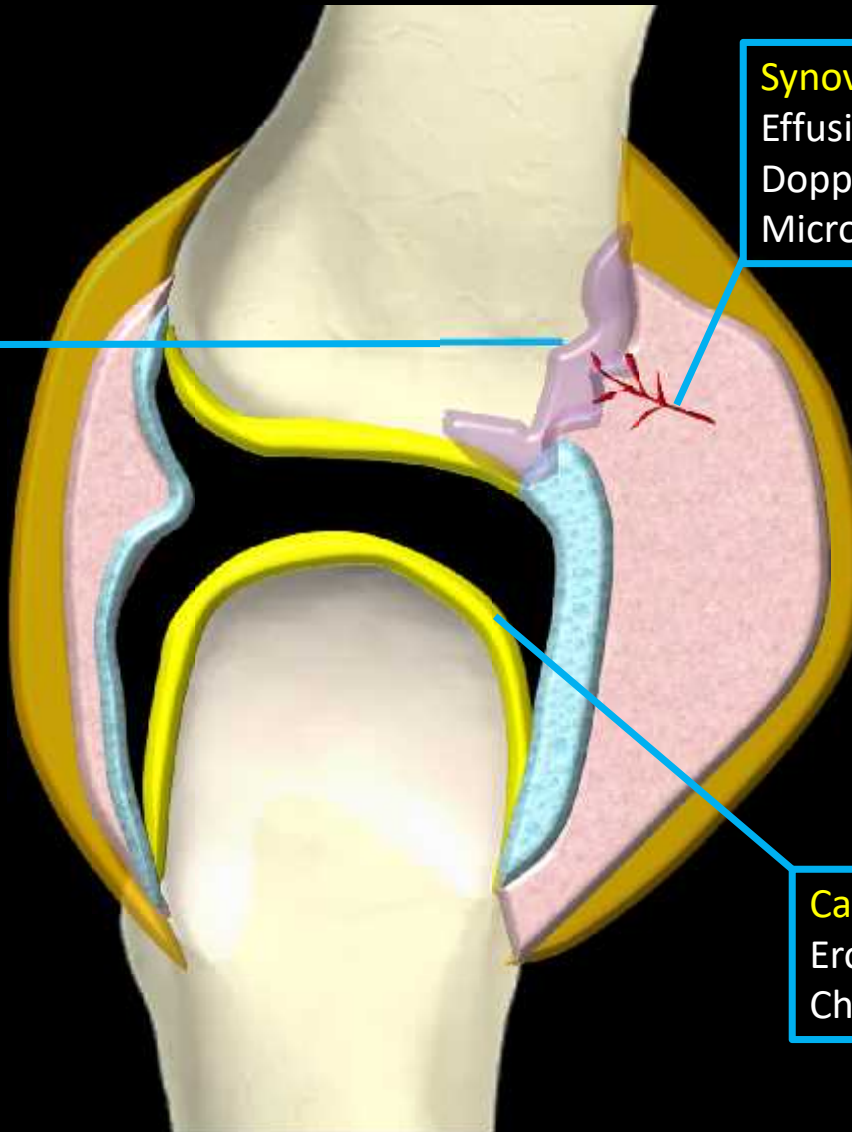
Erosions
Marrow not assessed

Synovium

Effusion vs synovitis
Doppler for neovascularity
Micro-vascular flow

Cartilage

Erosions
Chondrocalcinosis



US advantages

Better spatial resolution

Clinical correlation

Dynamic

Vascularity

Patient choice

Cheap / available

But.....

Poor contrast resolution

Small FOV

Depth limitation

No marrow depiction

Poor image presentation

US

In practice, the question is

“Is there synovitis?”

Ultrasound can answer this very effectively

US technique

- Small high frequency linear probe
- Jelly stand-off / minimal pressure
- 3 finger technique
- Dorsal and ventral aspect
- Assess joints, tendons and bursae
- Scoring system – synovial hypertrophy, Doppler flow, erosions
- Eg. S1 D2 E0



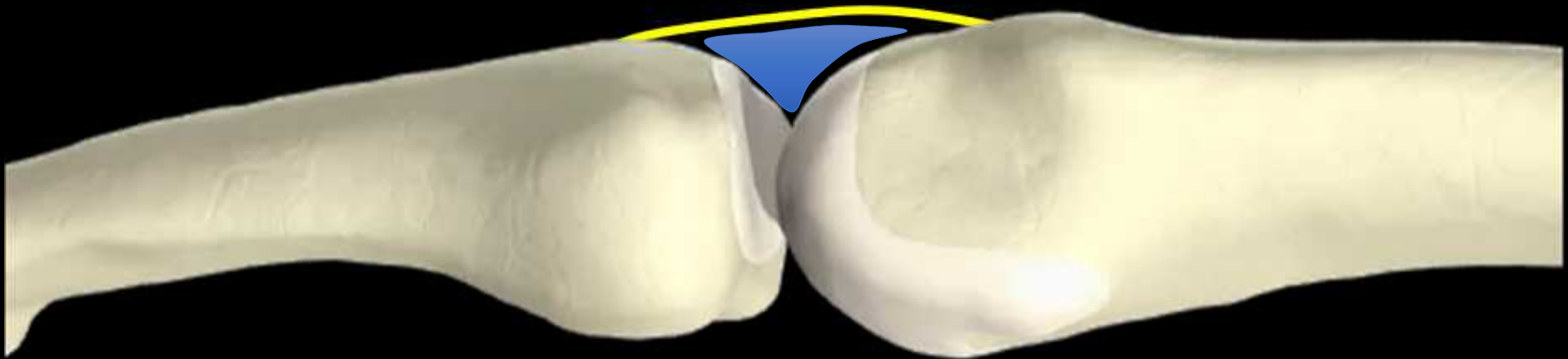
Effusion

- US very sensitive
- Low echogenicity with posterior enhancement
- Fluid compressible
- No flow on Doppler

Sensitive but non specific sign of joint disease

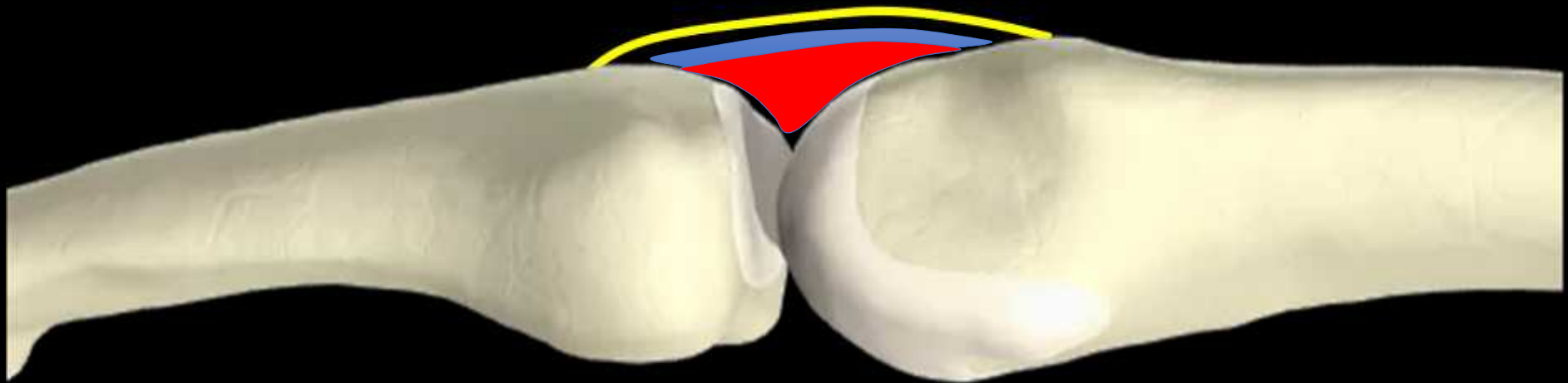
Synovial hypertrophy

Grade 0



Synovial hypertrophy

Grade 1



Synovial hypertrophy

Grade 2

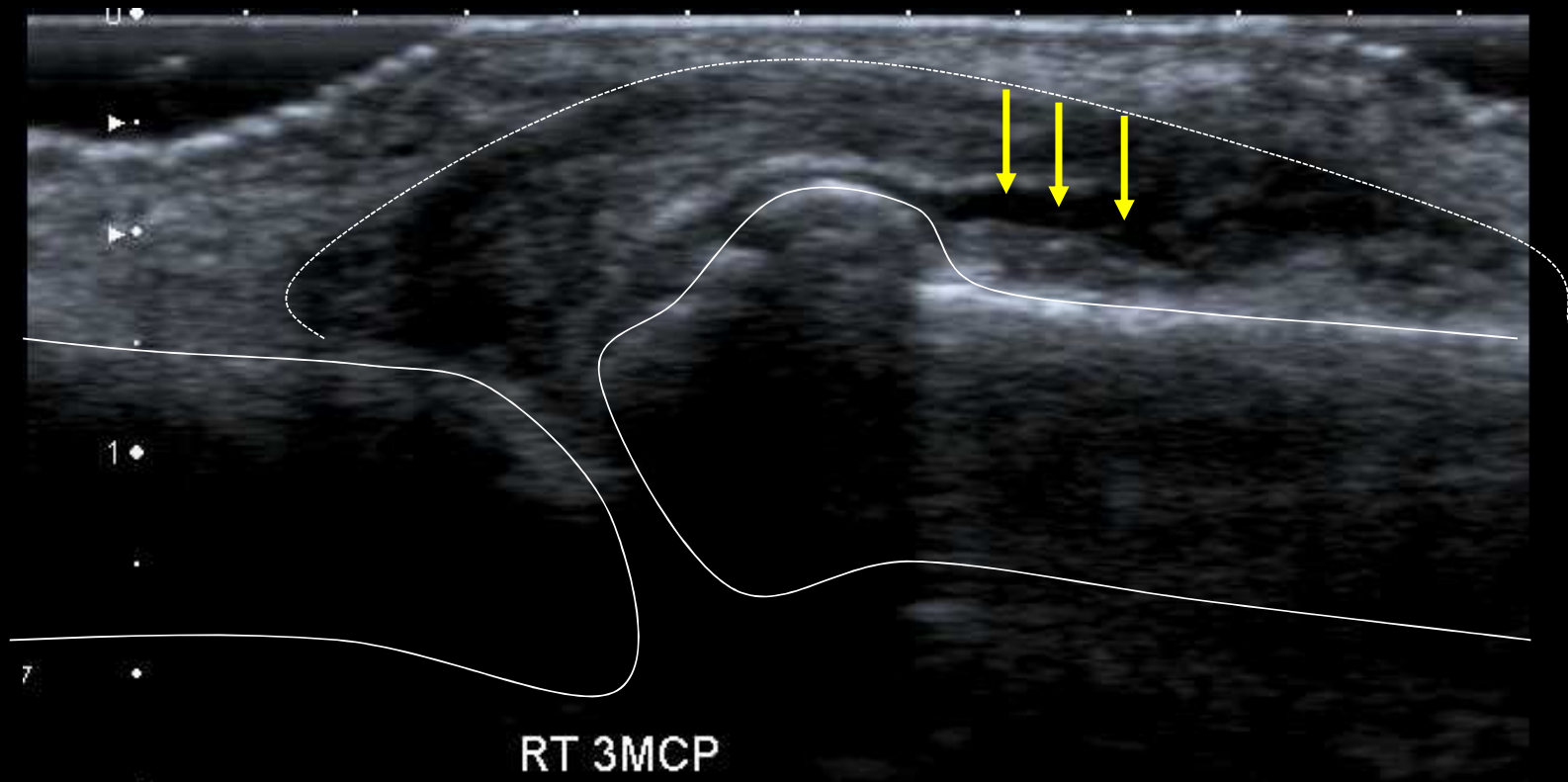


Synovial hypertrophy

Grade 3



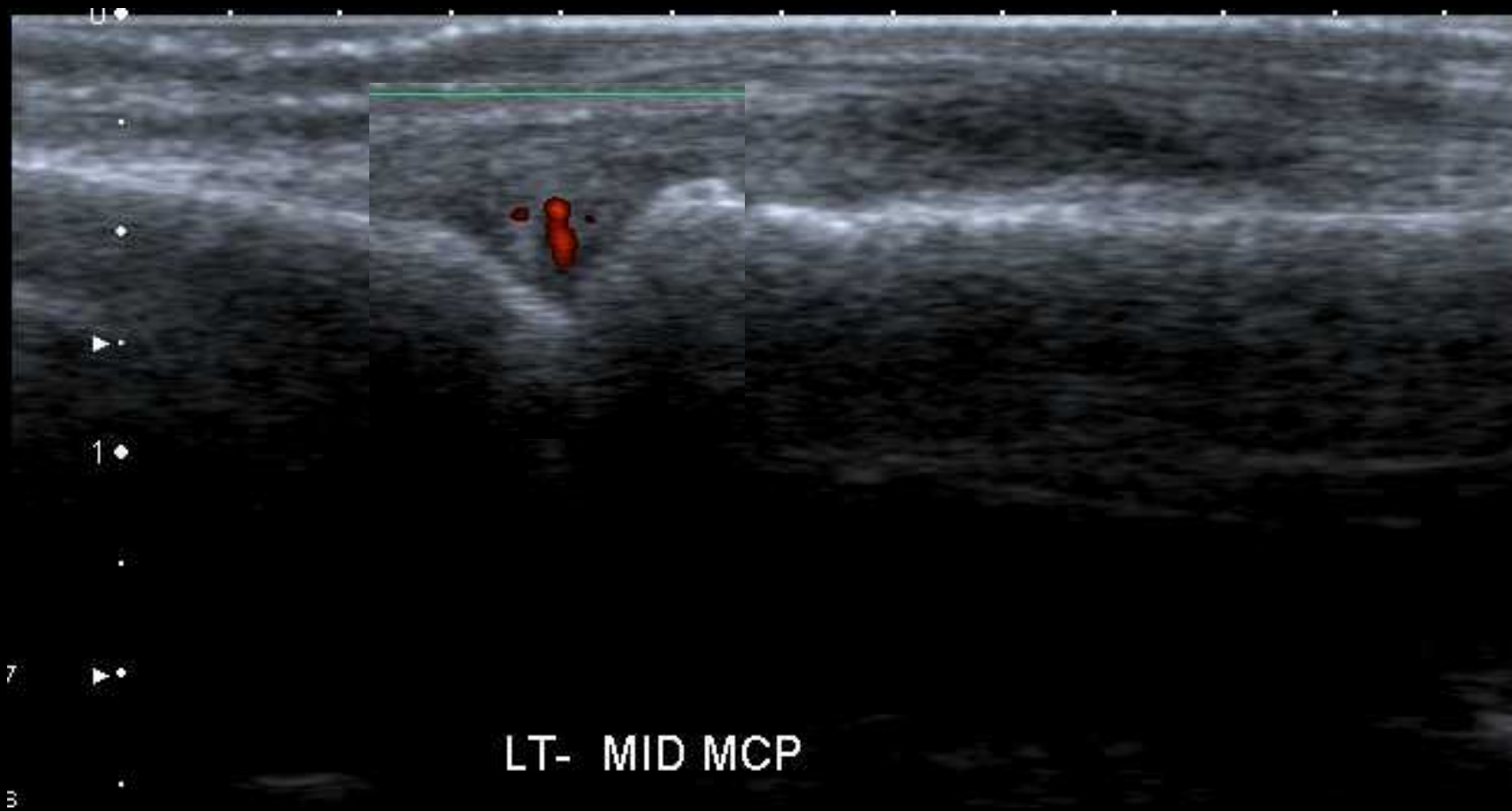
Synovial hypertrophy vs. fluid



Doppler

Power Doppler vs Colour Doppler

- less noise
- no aliasing
- no angle dependency



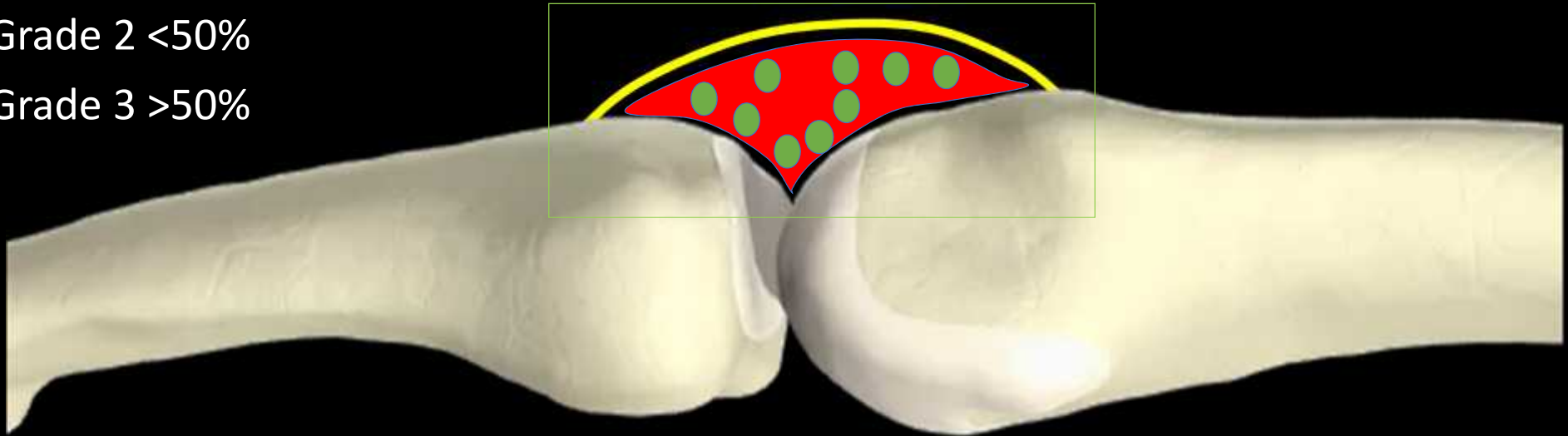
Doppler

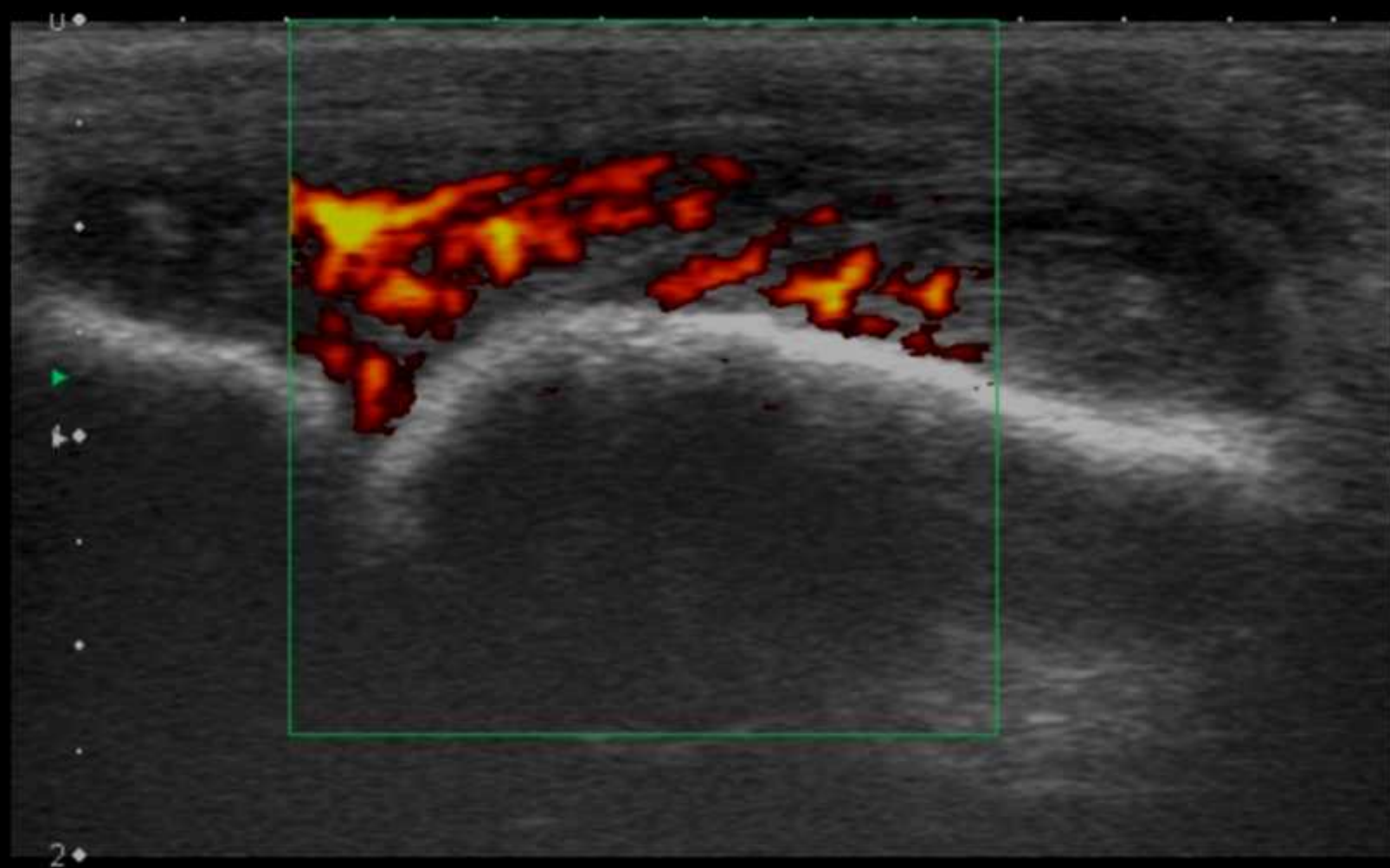
Grade 0

Grade 1 <3 spots, 2 confluent

Grade 2 <50%

Grade 3 >50%





LT MCP

Is there structural damage?

Rheumatologist

Is there structural damage?

Radiologist

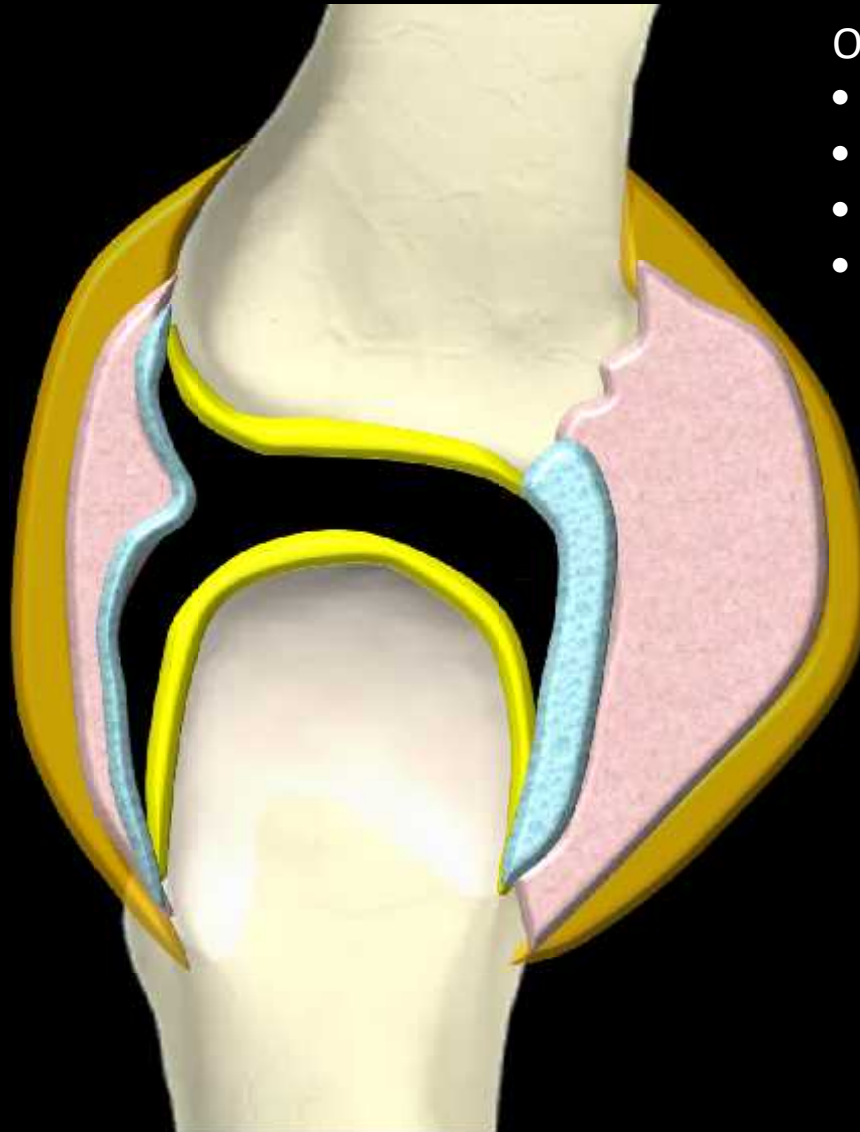
Erosions

Which imaging modality?

Erosions

Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

Erosions

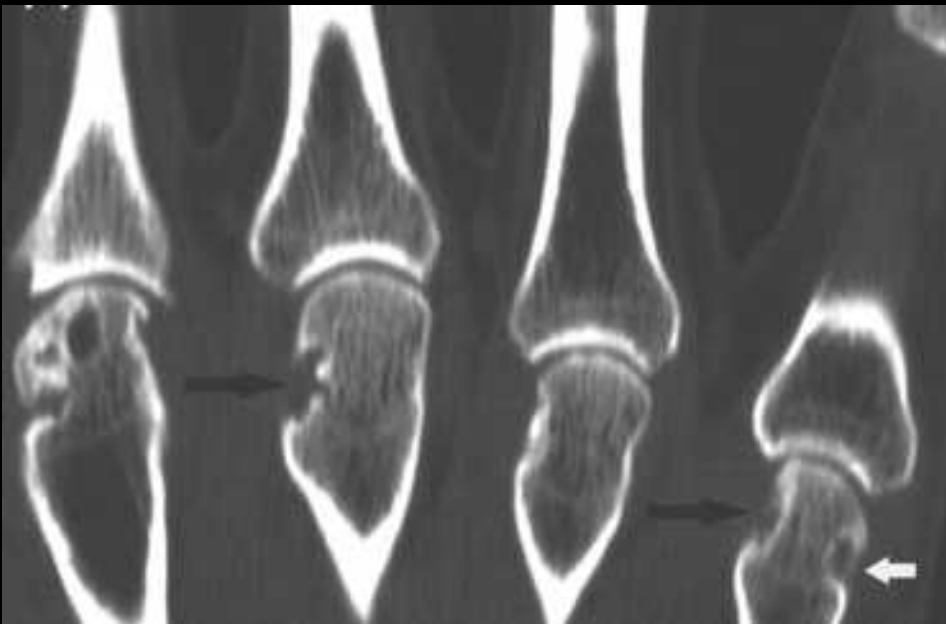


OMERACT

- Sharply margined bone lesion
- Juxta-articular position
- 2 planes
- Hypervascular pannus

Erosions are related to a poor long-term functional and radiographic outcome

Erosions



CT
isotropic imaging
Multiplanar



MRI
T1w

Are bone erosions detected by magnetic resonance imaging and ultrasonography true erosions?

Døhn et al. Arthritis Research & Therapy 2006 8:R110

MRI equivalent to CT



Dohn, U. M. *et al. Arthritis Res. Ther.* 10, R25 (2008).

US erosions

Intra-articular discontinuity of the bone surface visible in 2 planes

Active erosions associated with synovitis and neovascularity

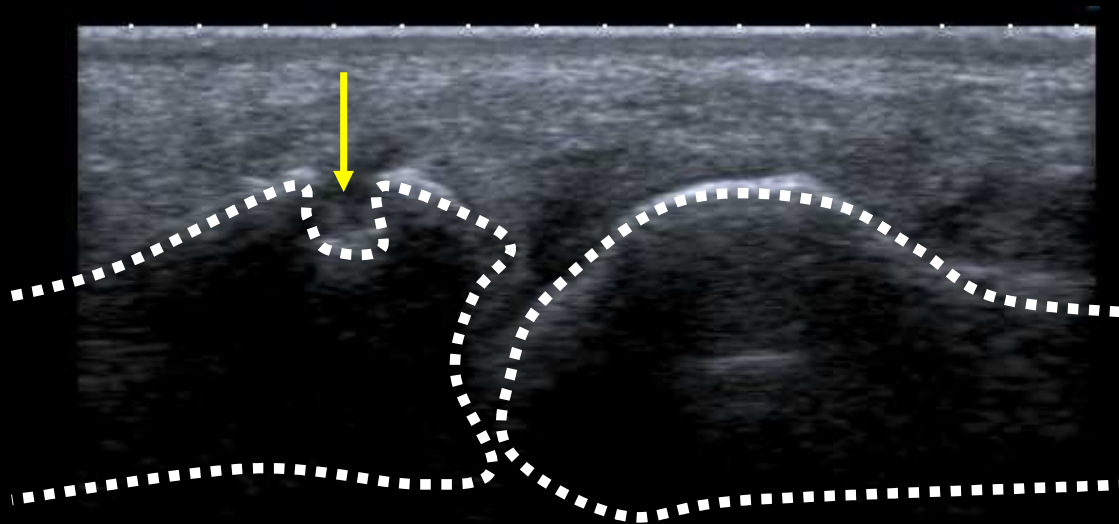


US erosions

US better than X-rays 6.5x erosions, 7.5x patients

Not as good as MRI

US assessment may be limited due to access



Szkudlarek et al

US of the MCPJs in RA: comparison with MRI and radiography

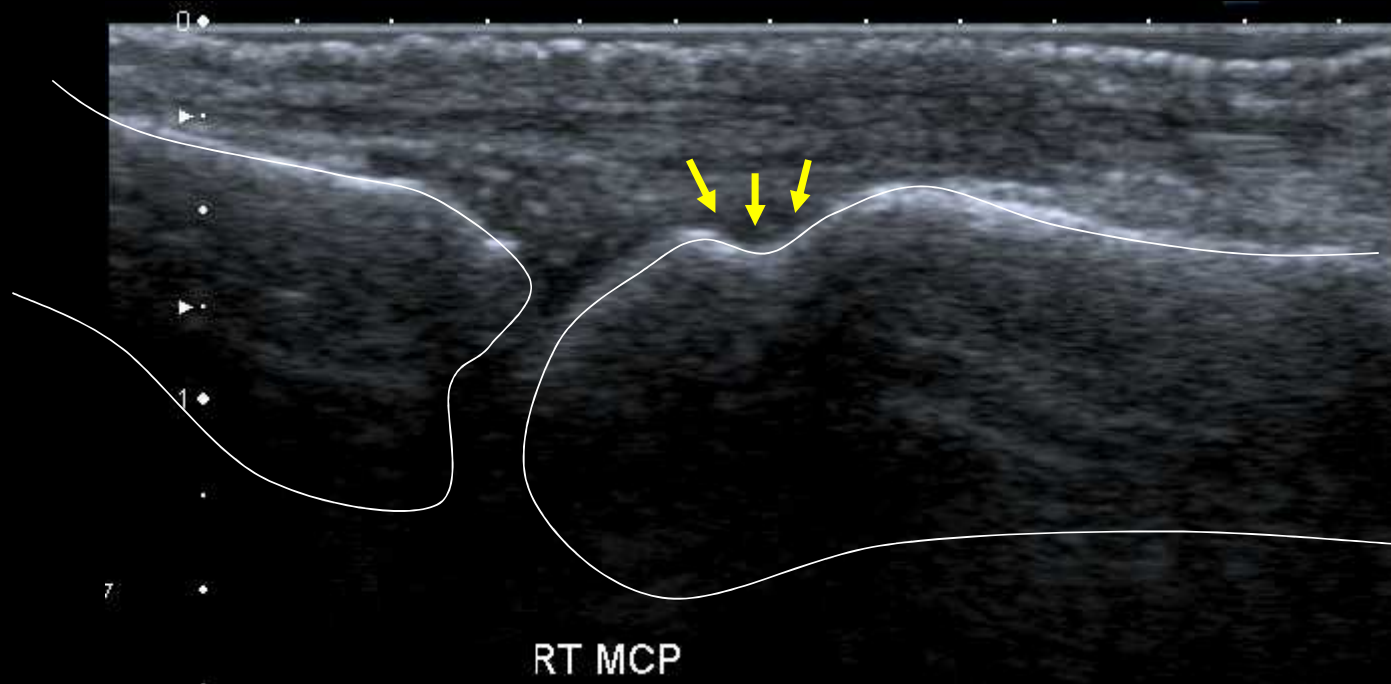
Arthritis Rheum. 2004 Jul;50(7):2103-12

US erosions - Doppler



Practical tip
Don't apply too much pressure

Pitfall



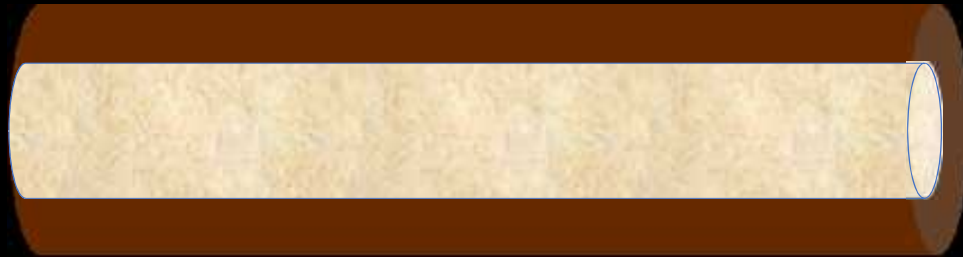
Is there tendon pathology?

Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

Tendon disease

- Tenosynovitis may solitary feature or predominate over synovitis
- Usually bilateral
- Extensor compartments wrist
- Medial and lateral ankle tendons

Tendinopathy



Tenosynovitis



Paratendinitis



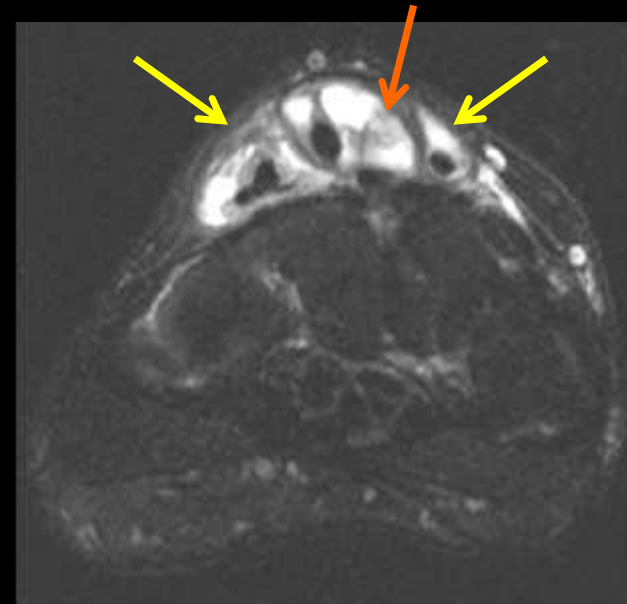
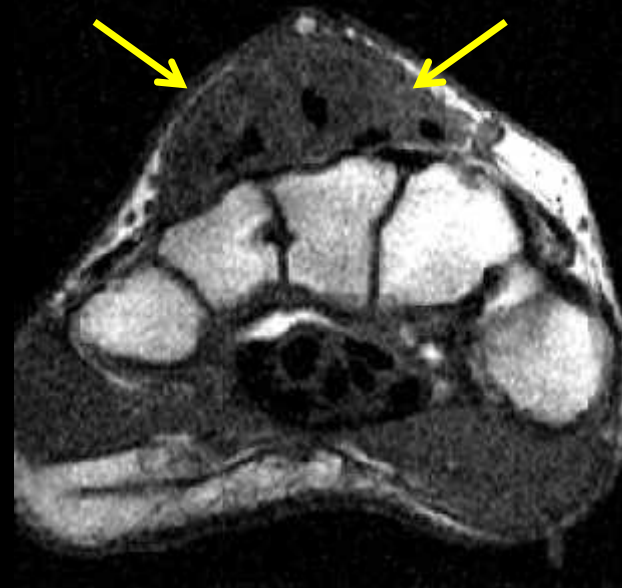
Tendinosis

~~Tendinitis~~

MRI

Tenosynovitis

- High T2 signal
- Fluid vs. synovitis
- Intrinsic tendon changes
- Tendon thickening

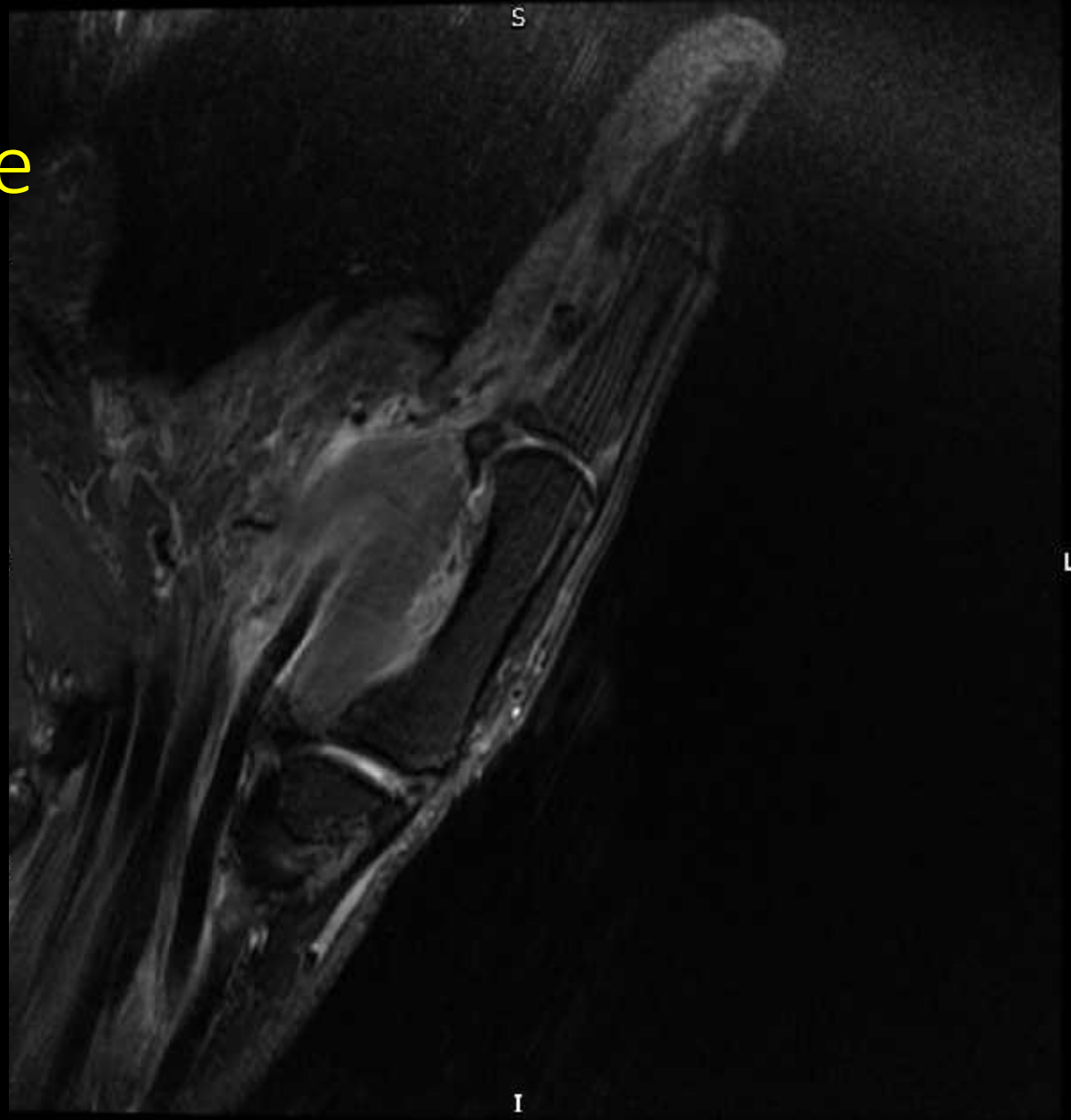


MRI - tenosynovitis



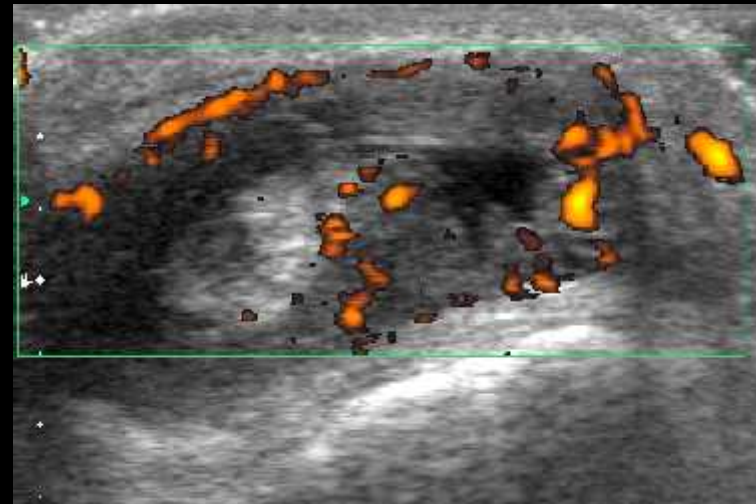
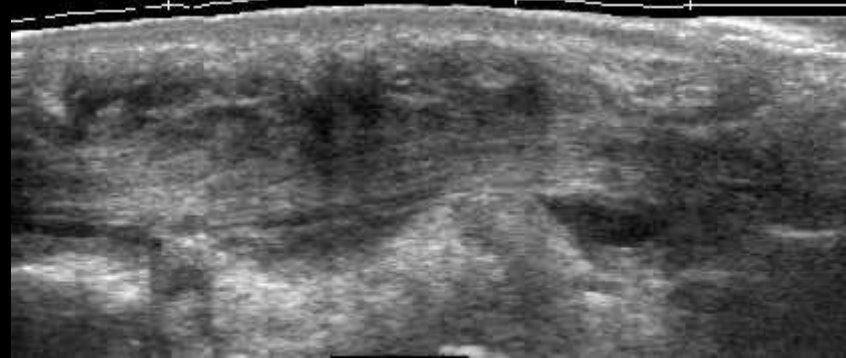
Deep palmar bursitis
Flexor tenosynovitis

MRI – tendon rupture



US - tenosynovitis

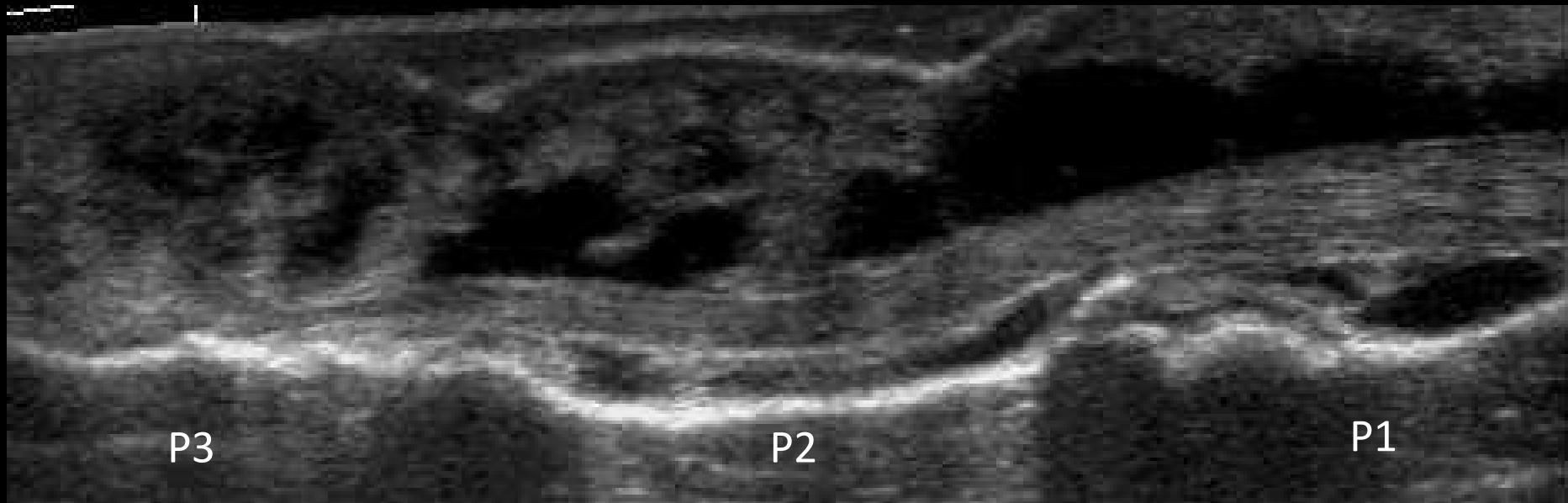
- Fluid
- Synovial thickening
- Altered echogenicity
- Increased vascularity
- Tendon tears



US - tenosynovitis



US - Tenosynovitis



Bursitis

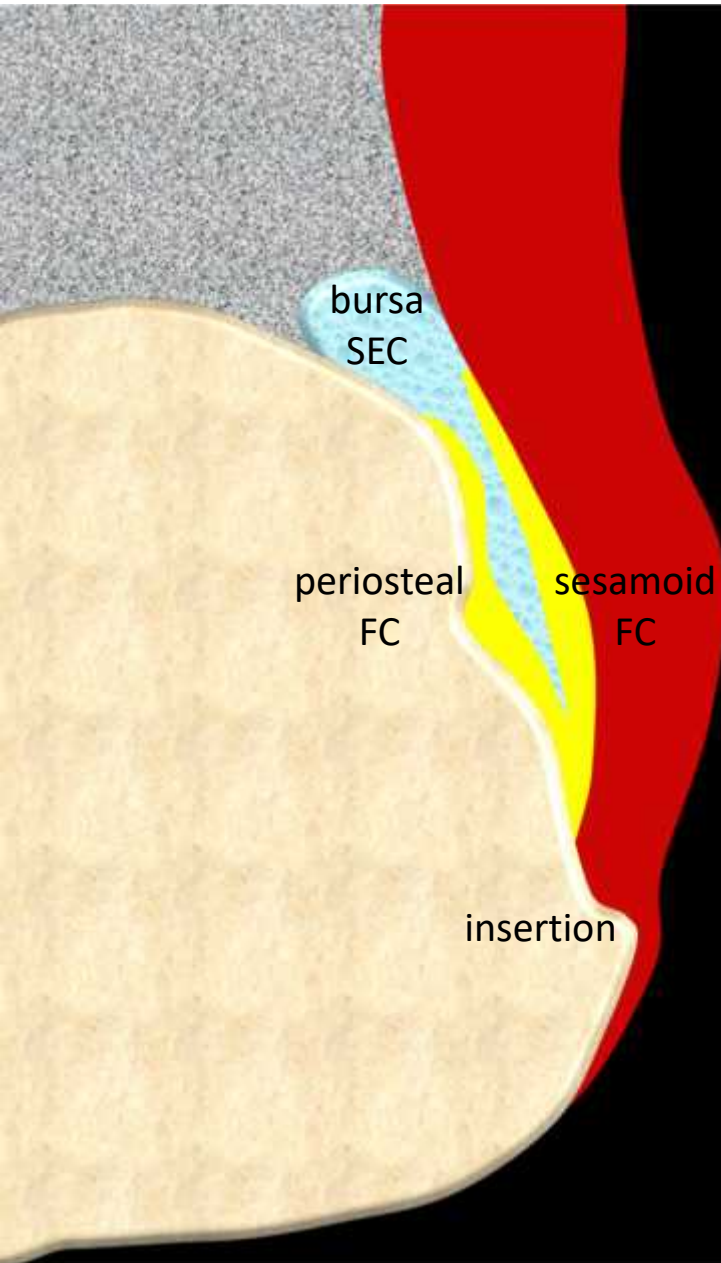
Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

Enthesis Organ

Distribute stress

Understanding helps explain the spectrum of abnormalities occurring adjacent to entheses including bursitis, periostitis, and synovitis.

Enthesopathy refers to any pathologic condition affecting the enthesis including traumatic, degenerative, inflammatory, metabolic, and endocrine disorders.



Olecranon bursitis

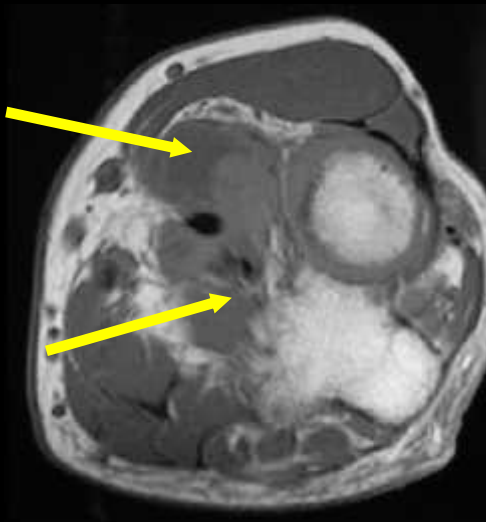
Exclude infection



Bicipitoradial bursitis

May be mass-like

- Can compress median nerve



Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

Has there been a response?

Rheumatologist

Has there been a response?

Radiologist

How to follow up

Qualitative or quantitative?

Which imaging modality?

Monitoring response

- For assessing treatment response
- Critical for development of new therapies
- Clinical endpoints (synovitis, erosions, osteitis) are poorly assessed by plain films
- Imaging relies on US and MRI

OMERACT-EULAR

*Outcome Measures in Rheumatology Clinical Trials
European Alliance of Associations for Rheumatology
(European League against Rheumatism)*

- To develop and validate outcome
- US in Rheumatoid Arthritis outcomes

RAMRIS

Rheumatoid Arthritis MRI Score

Finding

- Synovitis
- Bone oedema
- Bone erosion

Scale

3

4

10

Ostergaard et al

Rheumatoid arthritis magnetic resonance imaging studies.

J Rheumatol 2003;30:1385-6

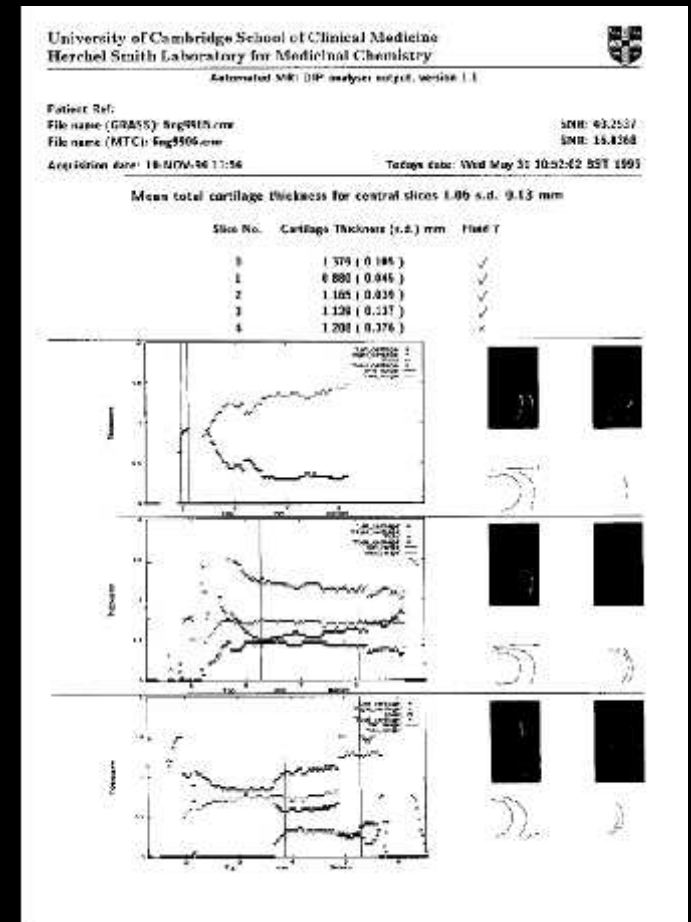
Issues

- Quantification

Several techniques
Dynamic scanning
Synovial volumes
?reproducibility

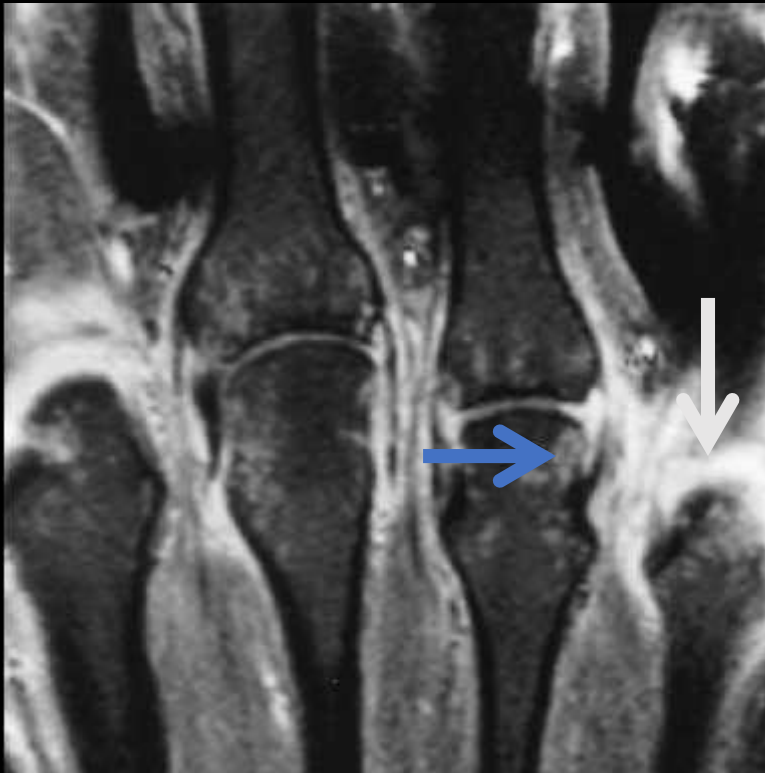
- Need for contrast

Not real time flow
Effusion vs synovial hypertrophy
T1fatsat gold standard
Time consuming
Expensive

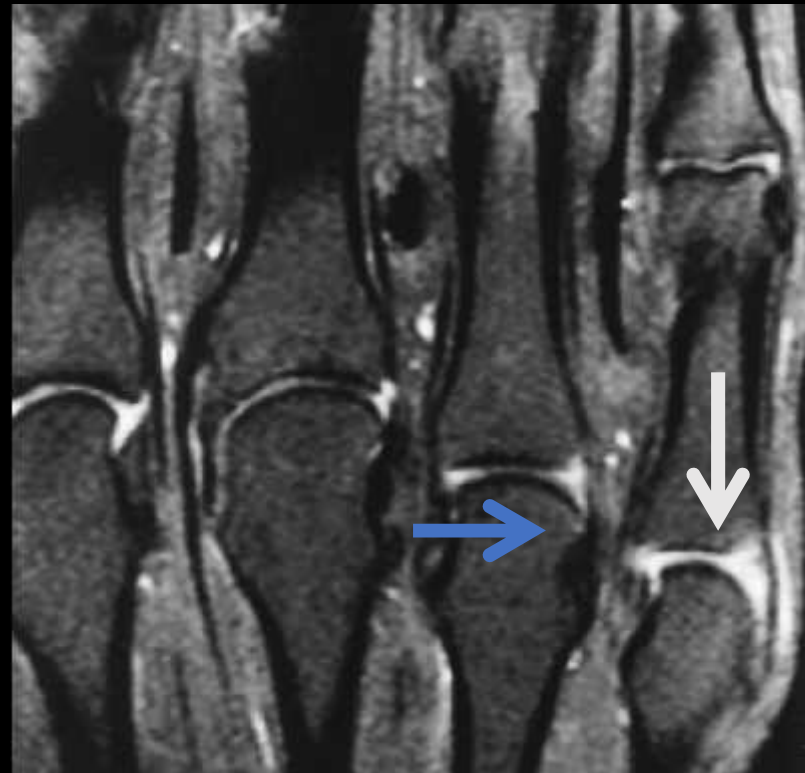


Monitoring response

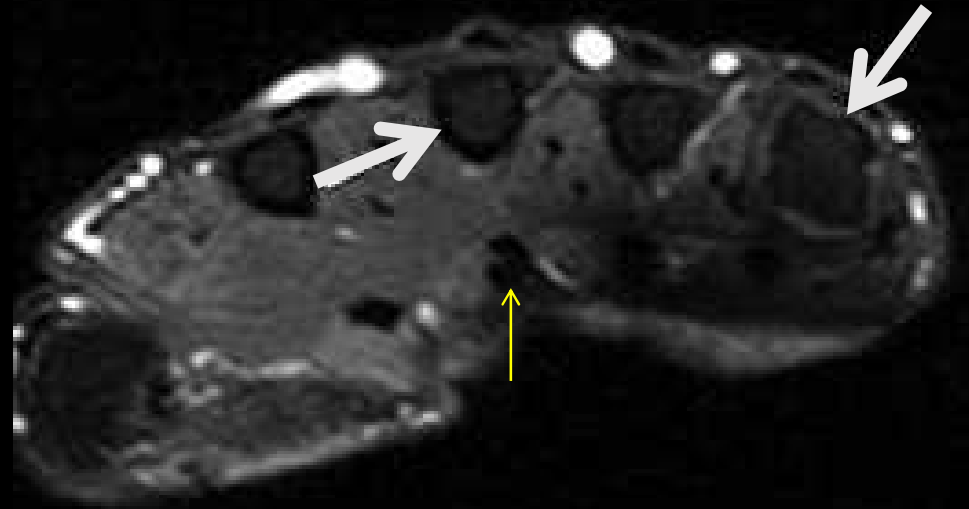
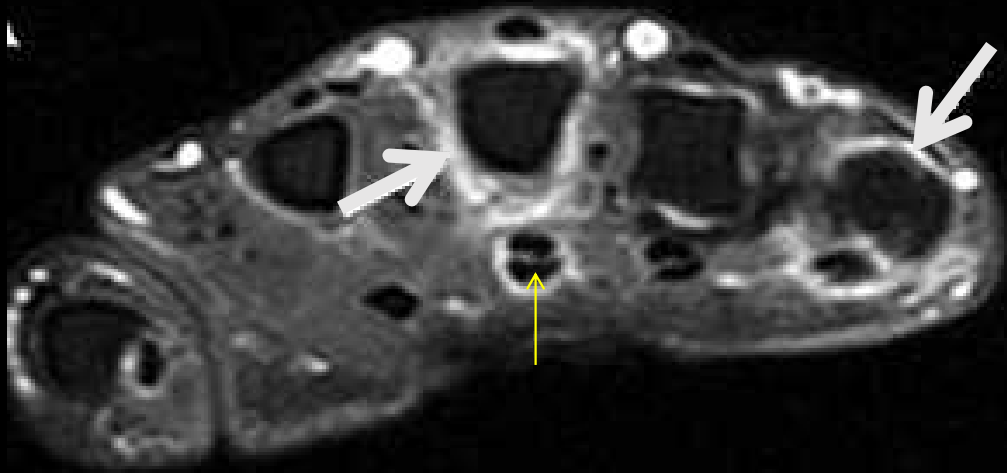
Pre



Post



Monitoring response



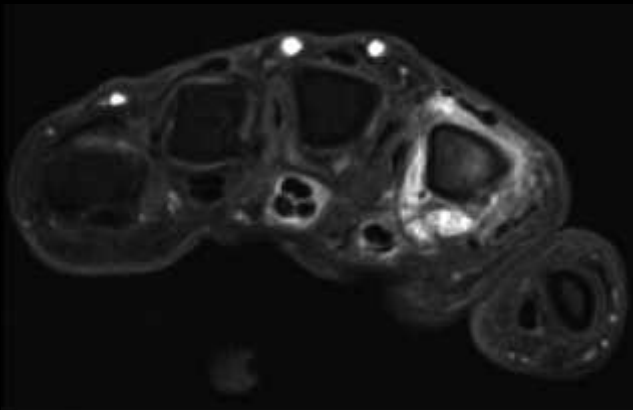
Synovitis maps



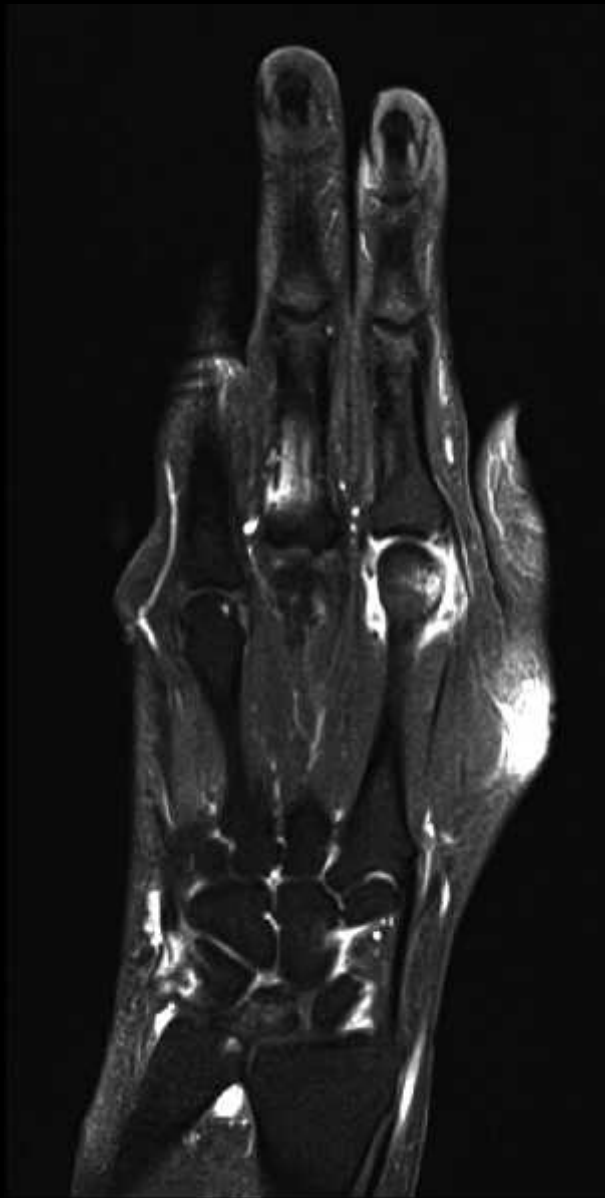
Karlo et al
Eur Radiol (2011) 21:1499–1508



FLASH summation



Not practical clinically



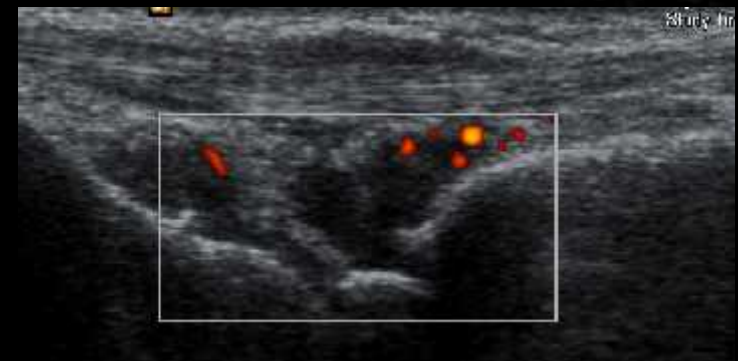
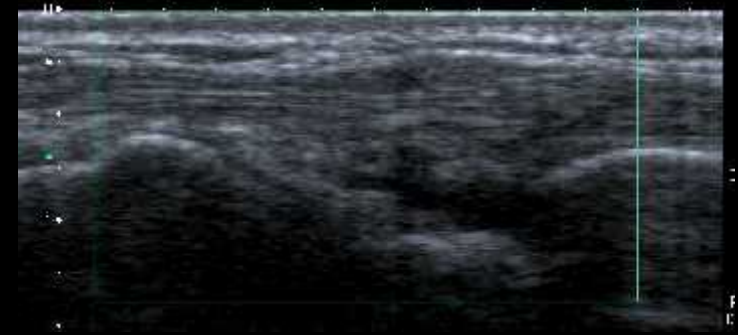
US evaluation

Qualitative

- Synovitis
- Effusion
- Erosions
- Doppler

Semi-Quantitative

- Grading Score 0-3
- 20/22/28 joint
- Volume measurements
- Vessel counts
- Doppler signal
- Colour fraction



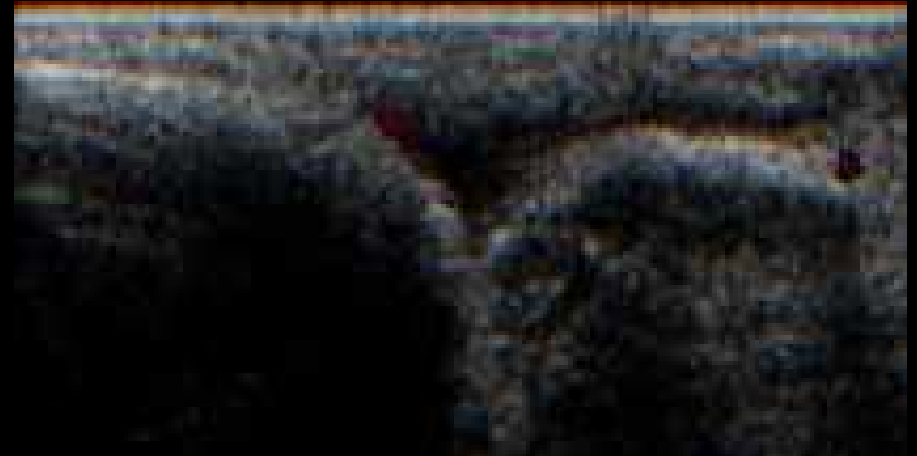
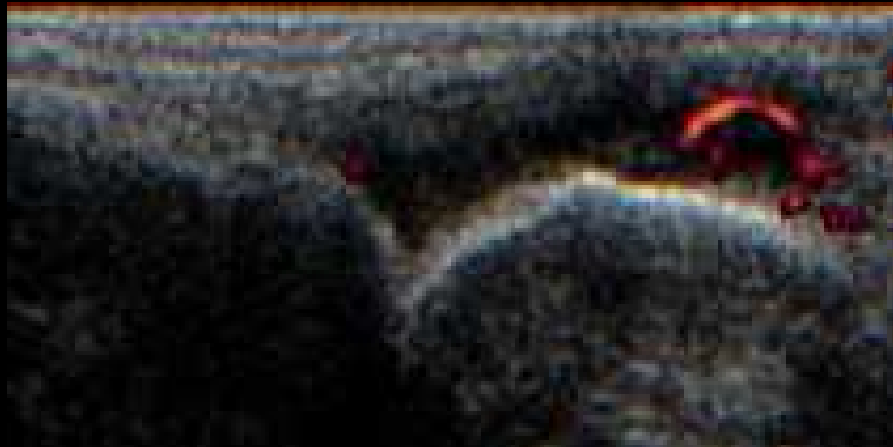
US quantification

- Downey DB et al *Clinical utility of three- dimensional US*. Radiographics 2000;20:559–71
- H Røgind et al *Quantitative ultrasonography in rheumatoid arthritis: evaluation of inflammation by Doppler technique* Rheum Dis 2001;60:690-693
- Taylor PC et al *Early RA patients on infliximab therapy show significant changes in sonographic measures of joint vascularity and serum VEGF* Arthritis Rheum 2001, 44(suppl):S152

→ Teh J , Stevens K, McNally E Br J Radiol. 2003 Dec;76(912):875-9.
Power Doppler ultrasound of rheumatoid synovitis: quantification of therapeutic response

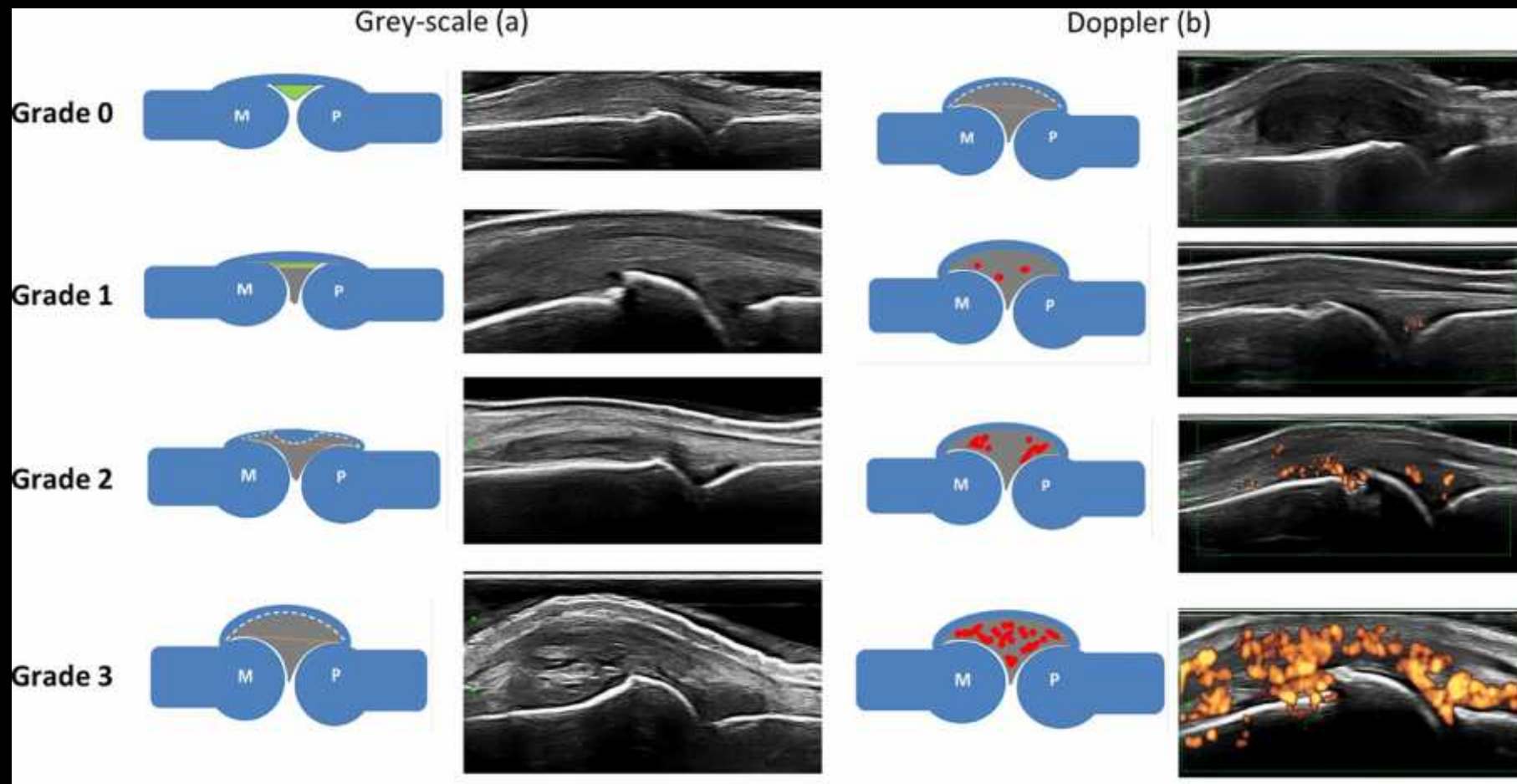
- Ellegaard, K et al *Ultrasound colour Doppler measurements in a single joint as measure of disease activity in patients with rheumatoid arthritis-assessment of concurrent validity* .Rheumatology. 48(3):254-257, March 2009.
- Platzgummera H *Quantification of synovitis in Rheumatoid Arthritis: Do we really need quantitative measurement of contrast-enhanced ultrasound?* Eur J Rad p237-241 (Aug 2009)

Monitoring response



POST THERAPY

US scoring



Monitoring

Just research or clinically relevant?

- Semi-quantitative grading is useful
- Quantitative US and MRI too time consuming

Pathology
Inflammation
Erosions
Tendons
Follow up
Differential

What is the differential?

Rheumatologist

What is the differential?

Radiologist

How to differentiate between various forms

Simple rules

Differential

- Over 150 forms of arthritis
- Several techniques
 - ✓ Aunt Minnie
 - ✓ Target joint approach
 - ✓ Which part of the joint is involved?

Rheumatoid arthritis

- DIPJ erosions uncommon
- 3 target joints
- radial aspect erosion



RA

Peri-articular osteoporosis

Joint space narrowing

Erosions

Soft tissue swelling

Subluxations

Swan neck and boutonniere

Z thumb



Osteoarthritis

- PIP and DIP > MCP



OA

- Heberden nodes
- Bouchard nodes
- Joint space loss
- Subchondral sclerosis



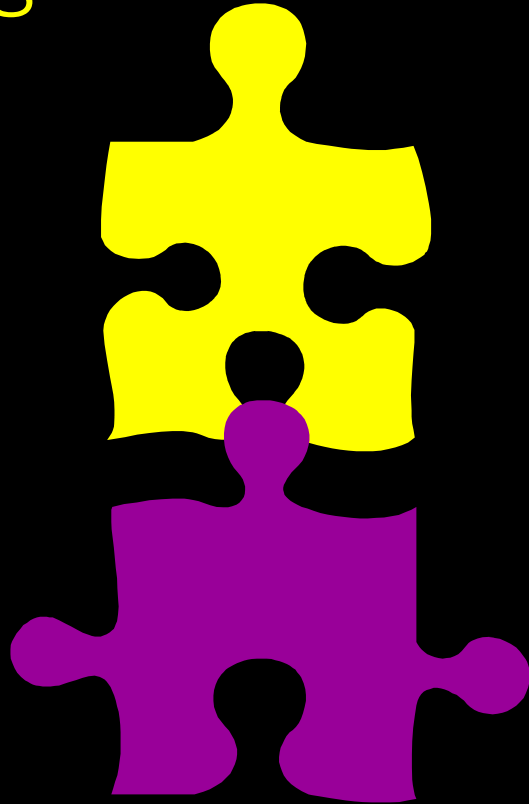
Erosive OA

- Similar distribution to OA
- Soft tissue swelling, subchondral collapse
- OA + gout/CPPD/CAD
- Gull wing erosion

Gull wing erosions



Interdigitation



Erosive OA

Gull wing erosion
Heberden node
Ankylosis



Erosive OA



Psoriatic arthritis

PIP and DIP > MCP
New bone formation

5 Groups

- DIPJs
- Ankylosis and deformans
- Resembles RA
- Oligo-articular
- Resembles ankylosing spondylitis



Psoriatic arthritis



Mouse ear erosion



Martel W et al 1980 AJR 134: 125–135



Psoriatic arthropathy

Rheumatoid pattern



Arthritis mutilans

Pencil in cup



Opera glass hand

Main en lorgnette



Arthritis mutilans



Psoriasis



- Whiskering
- New bone
- Mouse ears

Erosive OA



- Interdigitation
- Central collapse
- Gull wings

What the radiologist needs to know

- Pathology
- Inflammation
- Erosions
- Tendon disease
- Follow up
- Differential



A word cloud of medical terms related to joint inflammation, arranged diagonally on a black background. The central and largest word is 'inflammation' in blue. Other prominent words include 'Erosions' in light blue, 'Synovitis' in green, 'Prognosis' in yellow, 'marrow' in yellow, 'lesions' in green, 'oedema' in yellow, 'Structural' in green, 'Effusion' in yellow, and 'Bone' in yellow. Smaller words scattered around include 'diagnosis', 'Modality', 'Staging', 'Response', 'Active', 'Differential', 'steroids', 'MRI', 'Immunisation', and 'Joint'.

inflammation

Erosions

Synovitis

Prognosis

marrow

lesions

oedema

Structural

Effusion

Bone

diagnosis

Modality

Staging

Response

Active

Differential

steroids

MRI

Immunisation

Joint

Teh and Ostergaard
Rad Clin NA 2017

Thank you!

