Clinical MR Imaging of the Articular Cartilage

Standard and Novel Methods

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Chair: PM Parizel, MD, PhD

Conventional MR

…or CT Arthrography?

Conventional MR or MRA?

MRA still needed at 3T?

MR Arthrography

Little evidence of improved diagnostic ability of MRA for evaluating articular cartilage compared to 'state-of-the-art' conventional MRI at 3T

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Hip MRI: How Useful Is Intraarticular Contrast Material for Evaluating Surgically Proven Lesions of the Labrum and Articular Cartilage?

Am J Roentgenology 2013

Keyfacts

Assessment of cartilage has had varied success with MRI in the past, and remains challenging at present…

- Routine use of MRI for detection of articular cartilage defects less well accepted by clinical community

MR Image Quality

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The most important criterion for image quality is the signal-to-noise (SNR) or contrast-to-noise (CNR) ratio

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www.healtcare.siemens.com/MRI

Magnetic Field Strength (T)
1.5T-3T-(7T)

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Coil Type

dedicated high-resolution multichannel (8-16CH)

CAVE obese, acute swelling

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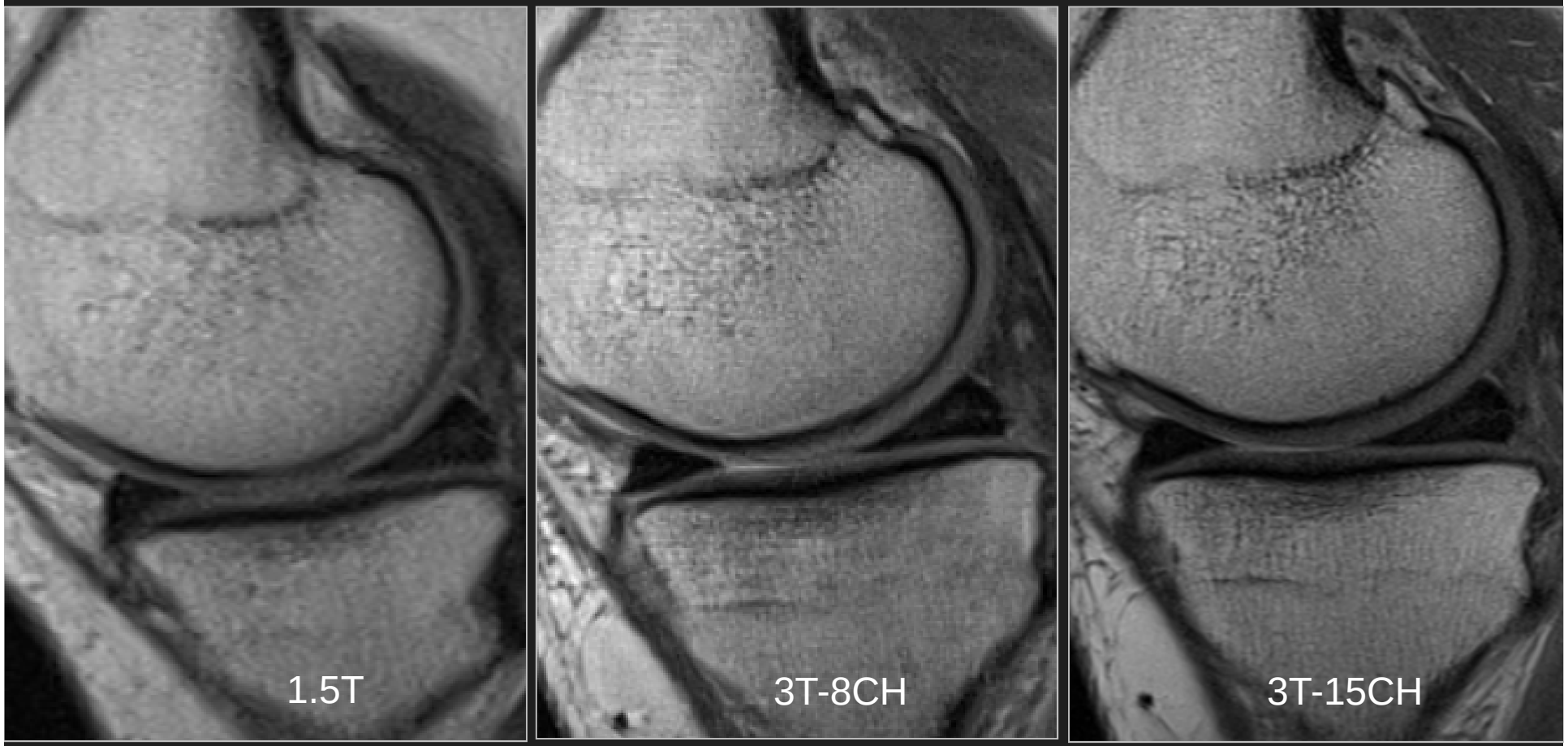
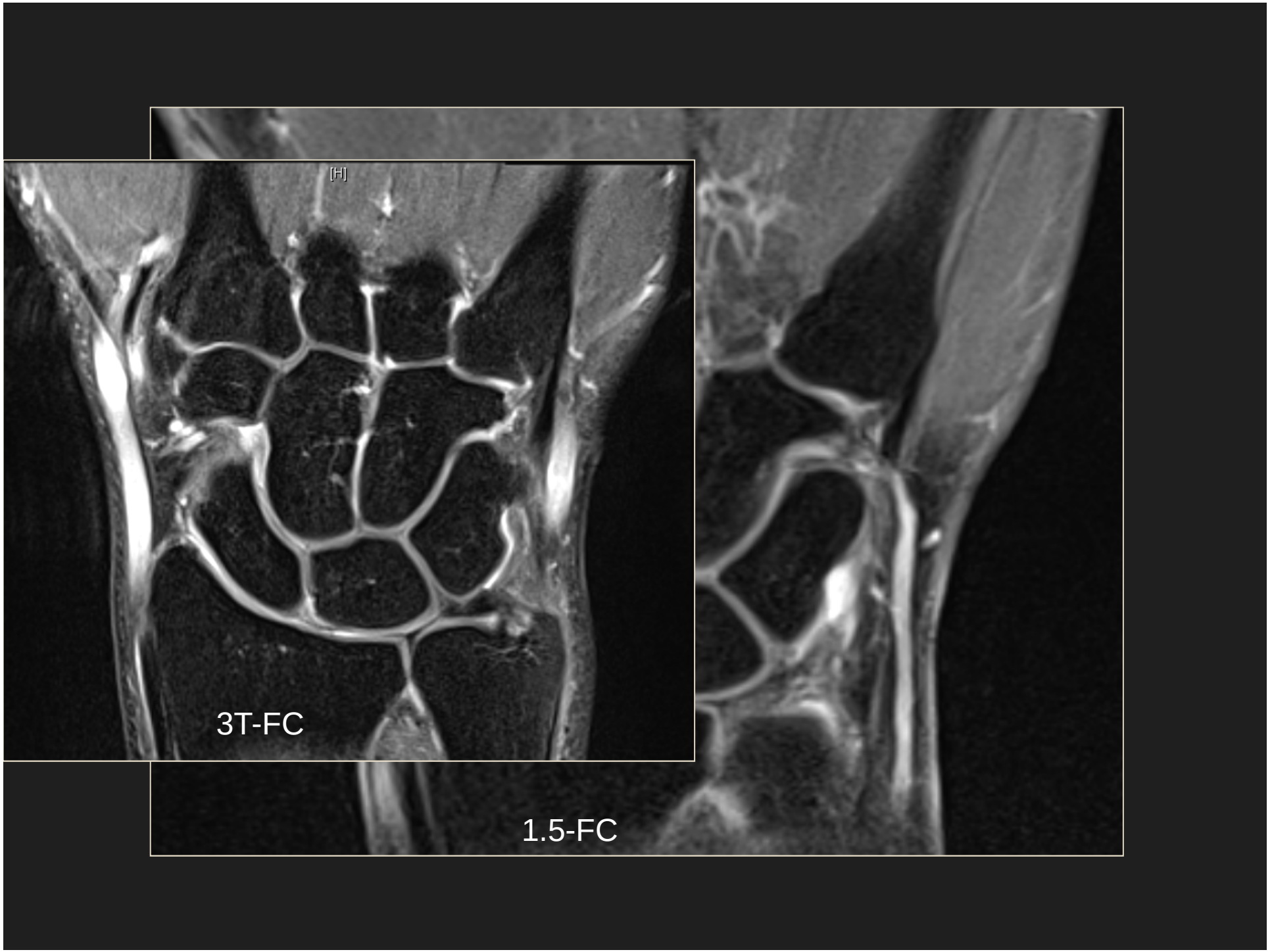
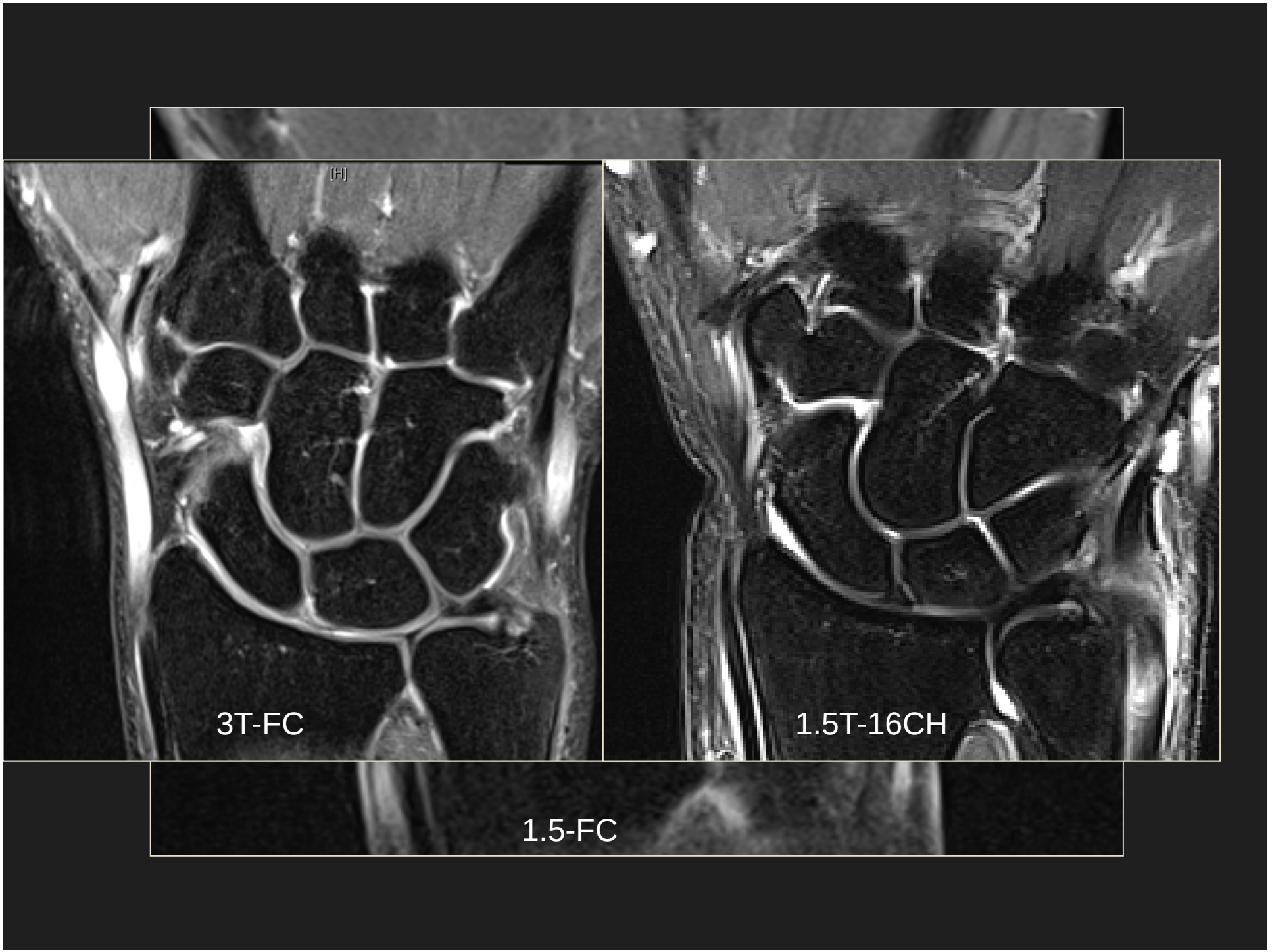
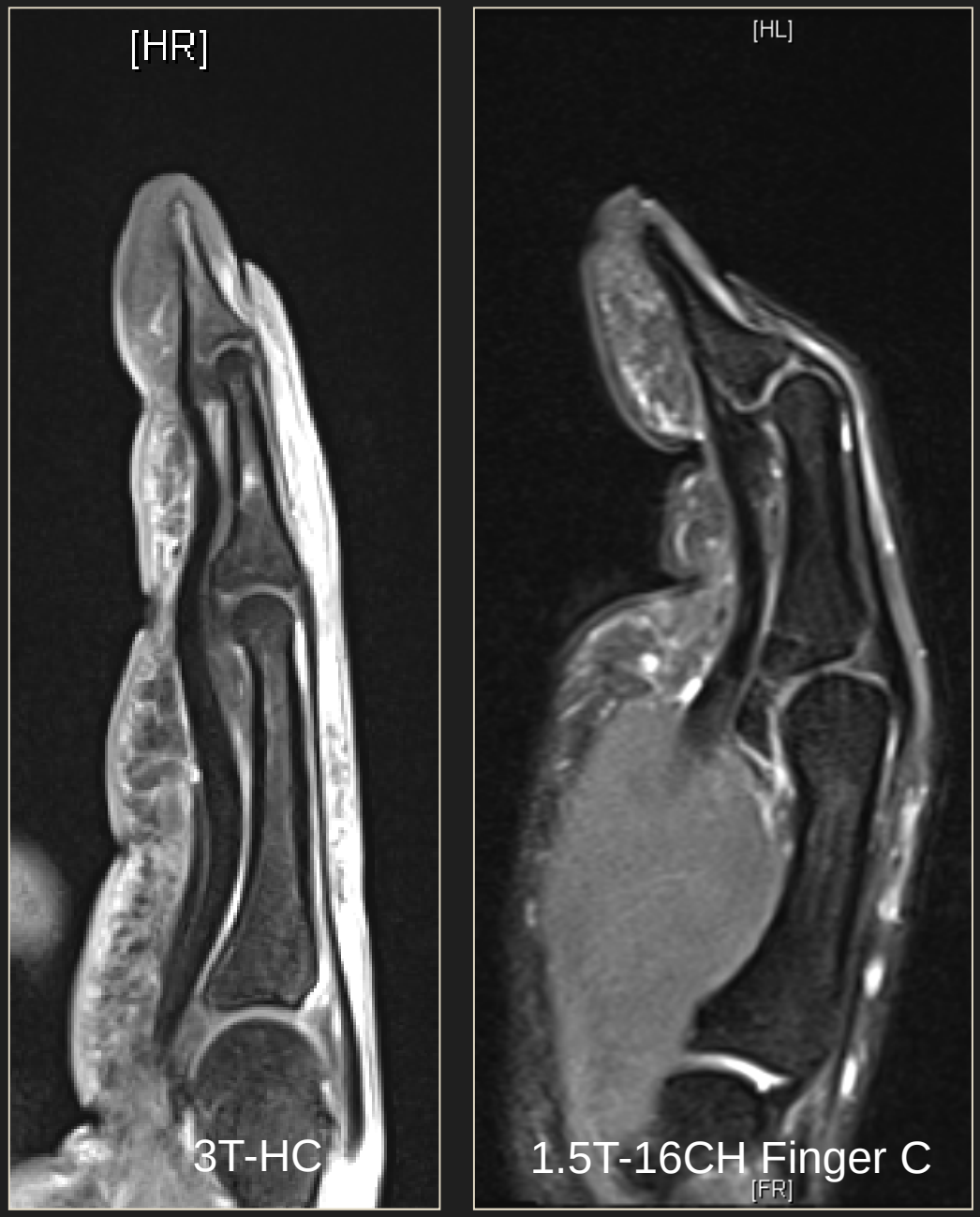

1.5T
3T-8CH
3T-15CH


1.5-FC

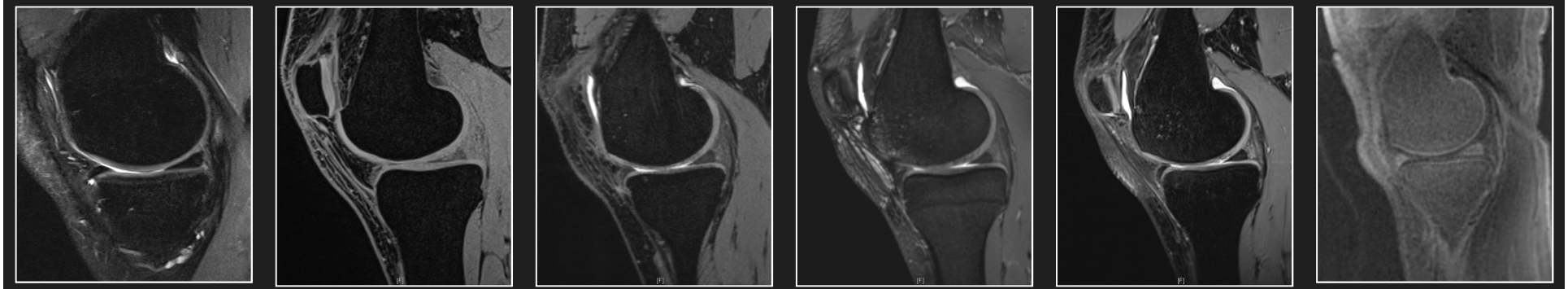

[H]
3T-FC
1.5-FC


[H]
3T-FC
1.5T-16CH
1.5-FC


[HR]
3T-HC
[HL]
1.5T-16CH Finger C
[FR]

Purpose

To review commonly used sequences for morphological MRI of articular cartilage

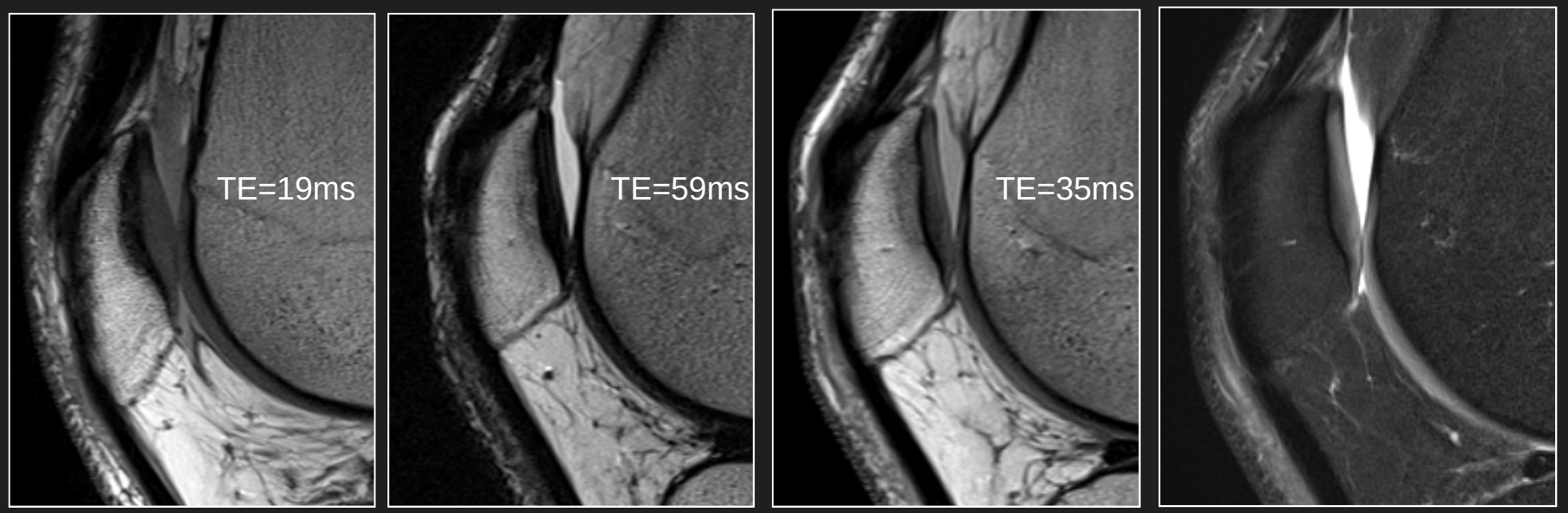


2D TSE | 3D SPGR | 3D DESS | 3D bSSFP | 3D TSE | 3D UTE

2D Turbo Spin Echo

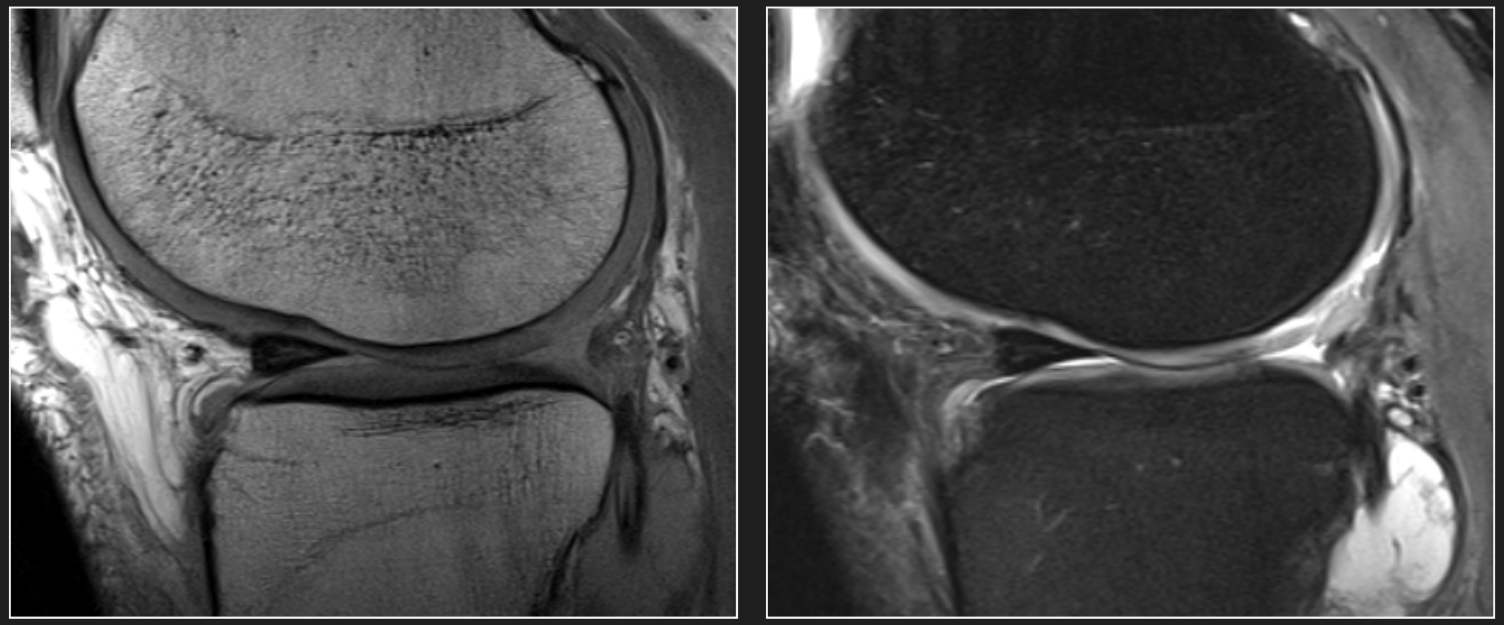
2D TSE sequences with intermediate- and T2-weighted contrast most commonly used

long TE increase CNR cartilage/fluid but decrease SNR



Fat Suppression

A fat-suppression (FS) technique is typically to add dynamic range and decrease chemical shift artifact



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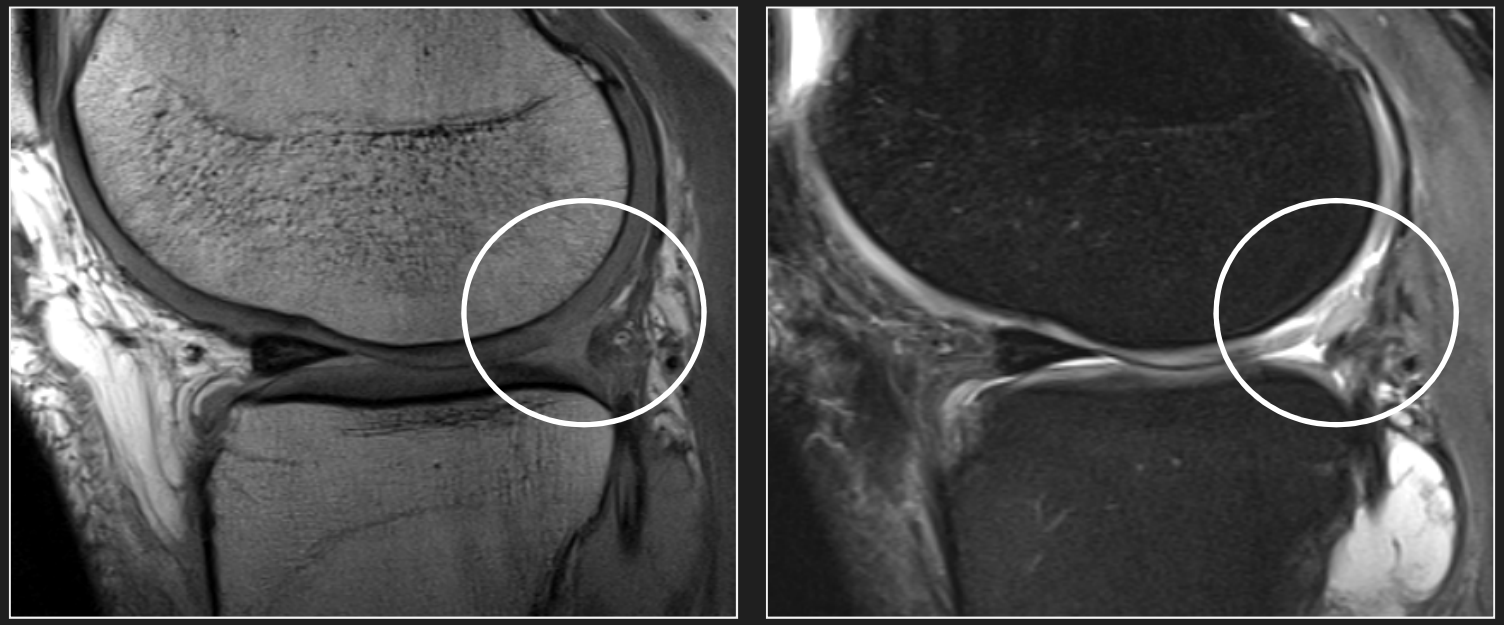
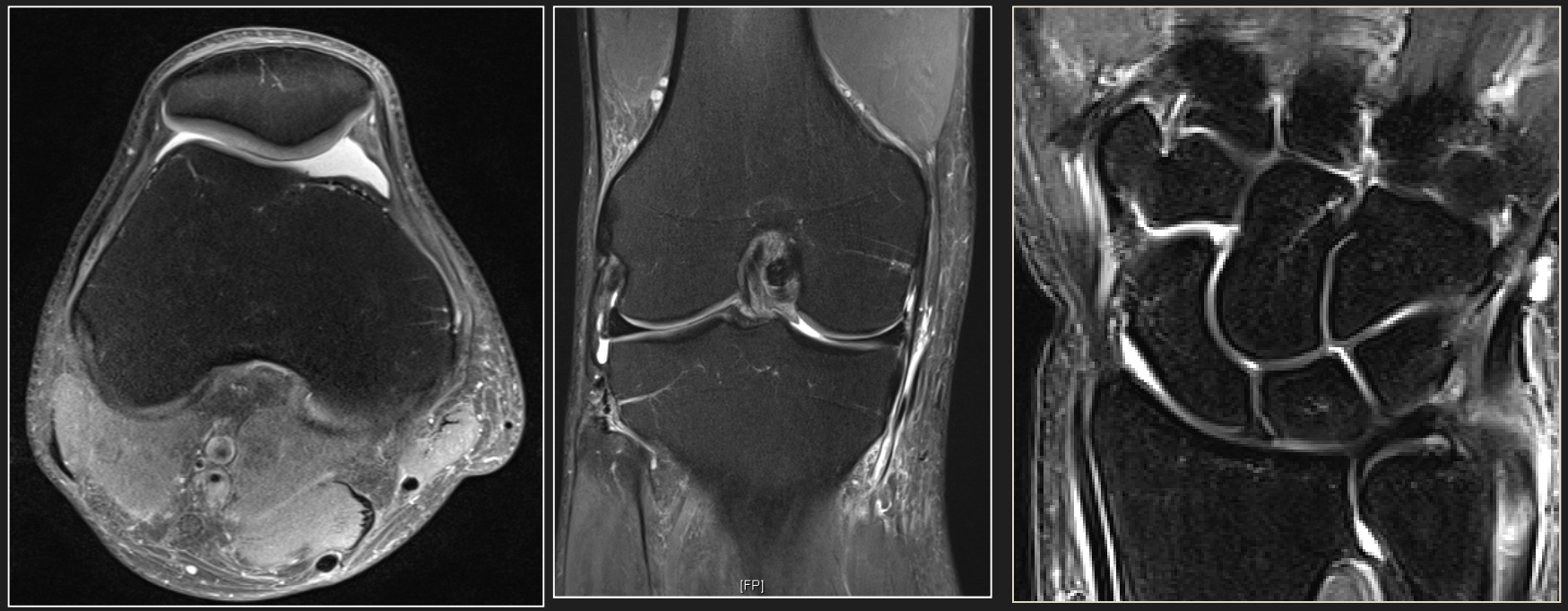


2D Turbo Spin Echo

2D TSE sequences with intermediate- and T2-weighted contrast

+ excellent tissue contrast and comprehensive assessment

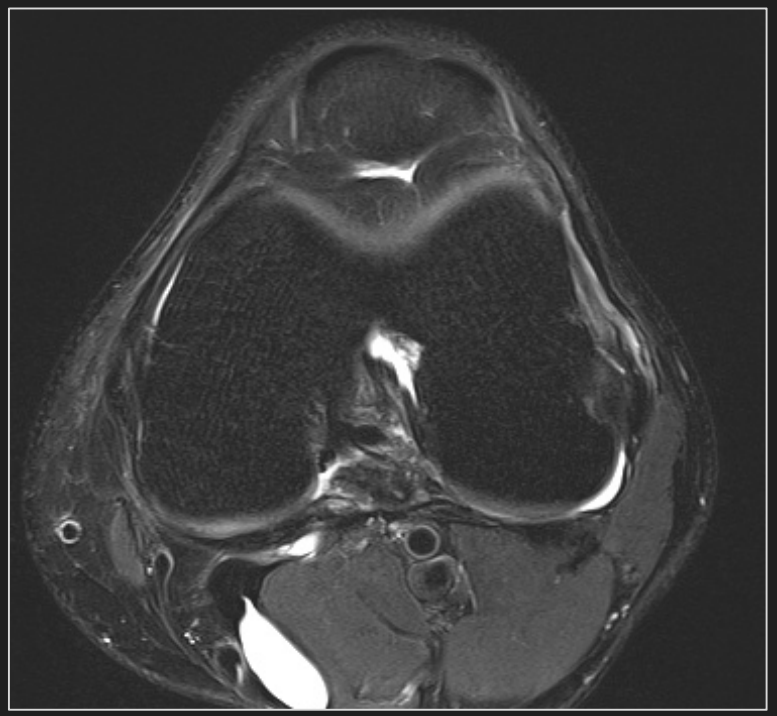


2D Turbo Spin Echo

2D TSE sequences with intermediate- and T2-weighted contrast

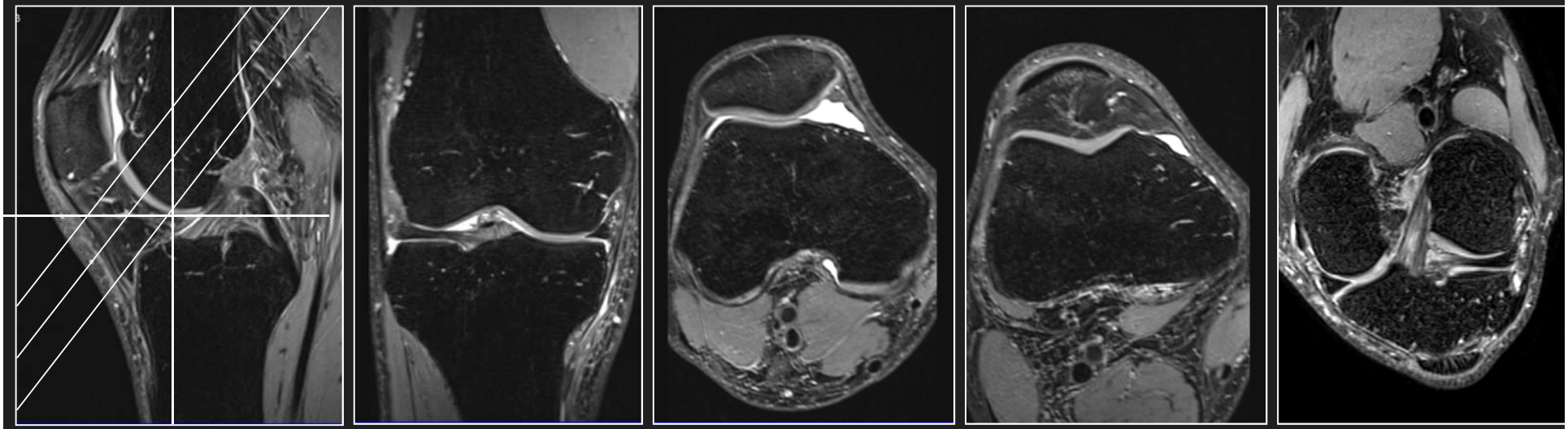
- Relatively thick slices (2-3mm) with interslice gaps (10% ST) resulting in PV averaging

oblique curved surfaces



3D Sequences

Isotropic (0.5-0.6mm) 3D sequences acquire volume data set providing opportunity to obtain thin continuous slices and multiplanar reformatted (MPR) images in any orientation



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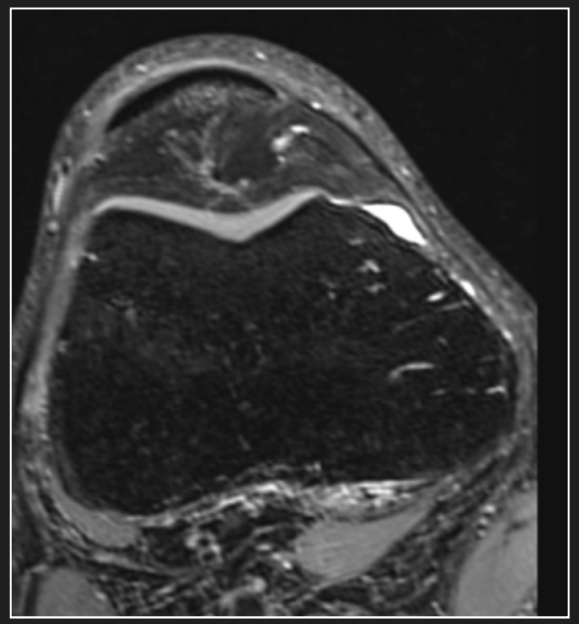
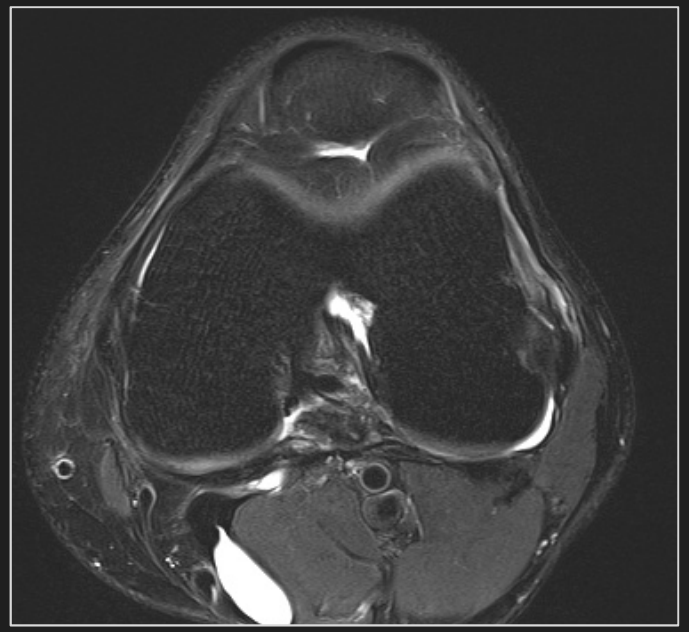


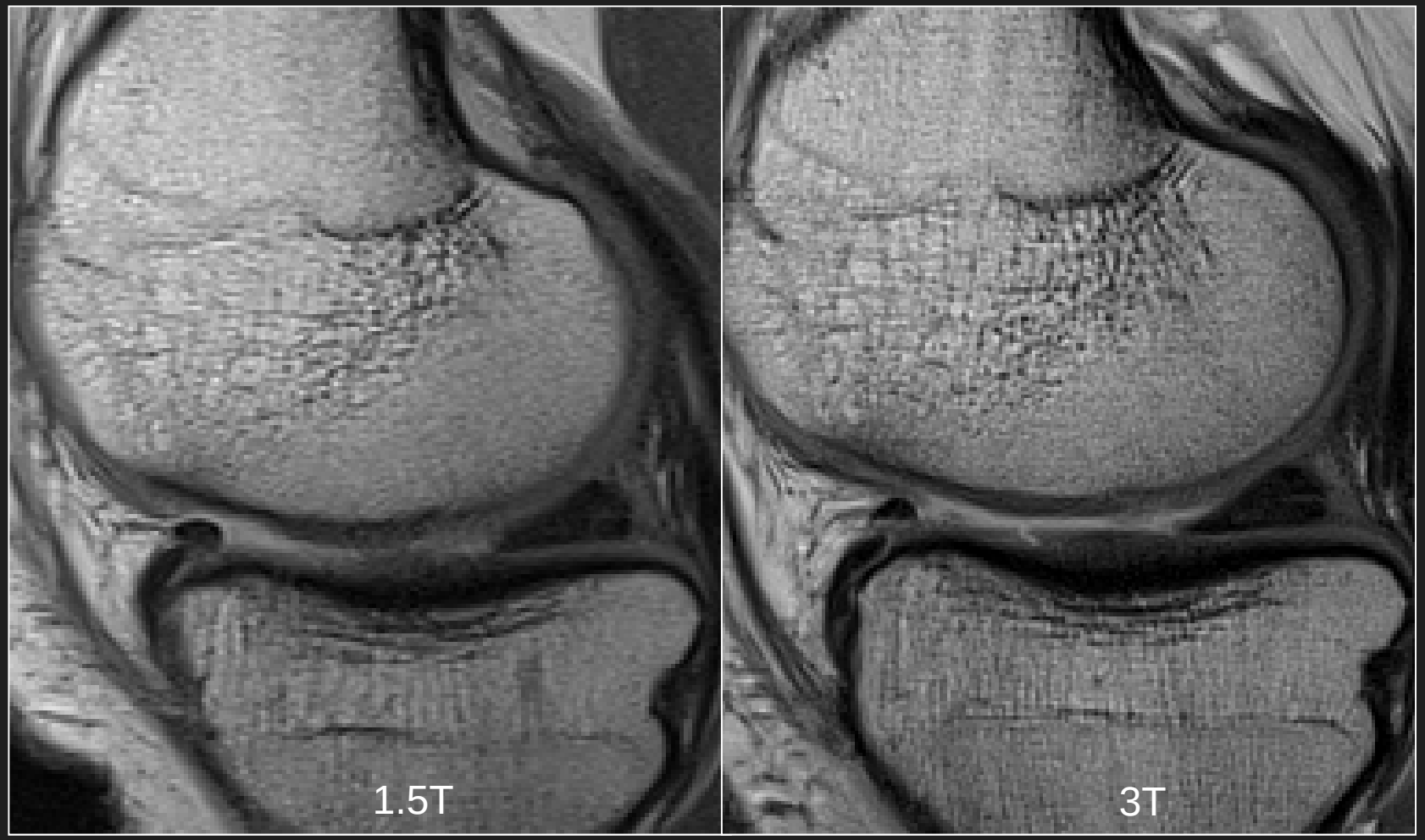


3D GRE Sequences

First and most commonly applied techniques for 3D joint imaging.
They can broadly be divided in low-fluid and bright-fluid sequences.

+ Volume quantification; - TA; dedicated cartilage

Does 3T do better?



Van Dyck P, Knee Surg Sports Traumatol Arthroscop, 2014;22(6):1376-84

Novel Techniques

Several advanced techniques for knee imaging exploit the particular advantages that come with the higher field strength, including

- 3D TSE
- T1 and T2 mapping
- Ultra Short Echo Time Imaging

3D Turbo Spin Echo

FS Sampling Perfection with Application optimized Contrast using variable flip angle Evolutions (SPACE)

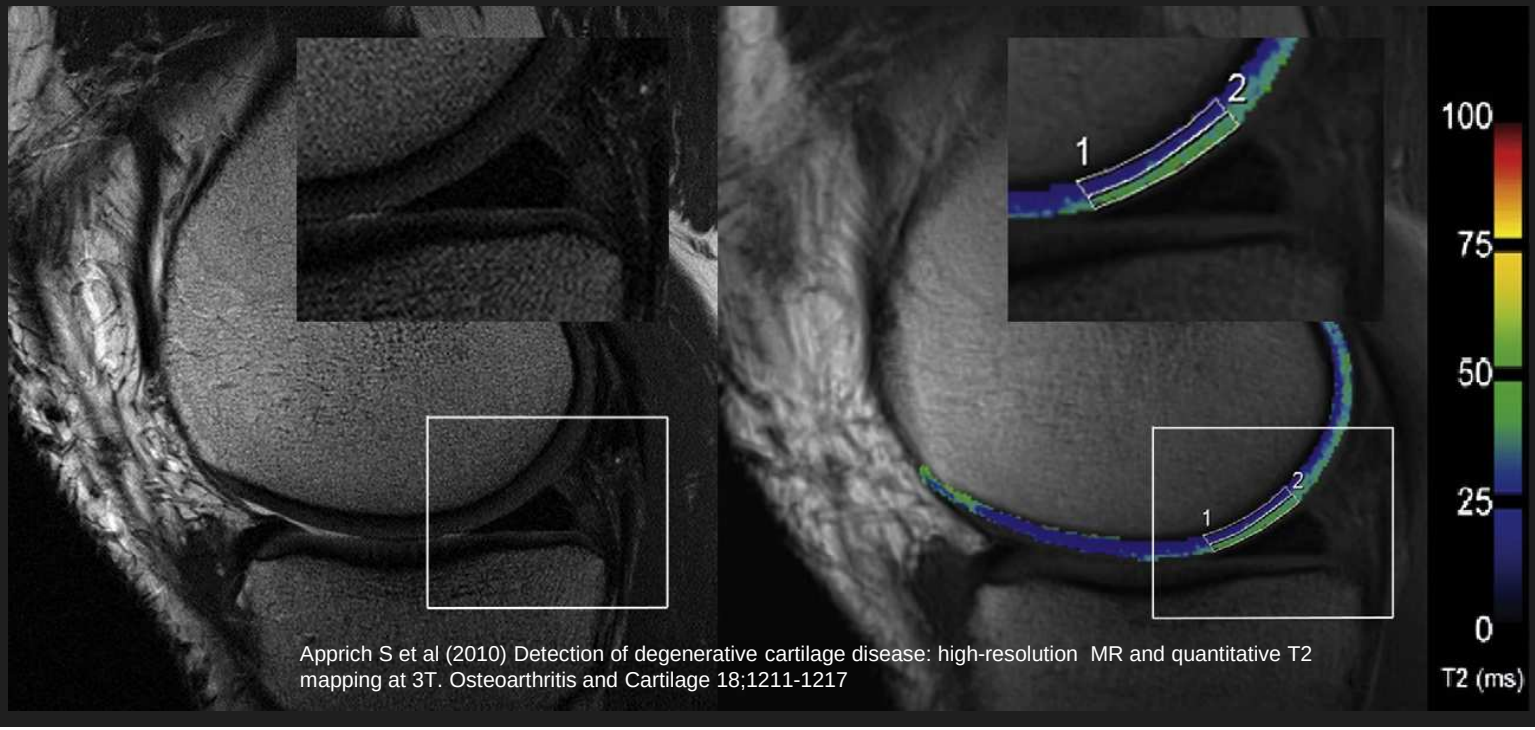
CUBE (GE); VISTA (Philips)

- Contrast properties similar 2D TSE
- Comprehensive assessment

MR Mapping Sequences

Quantitative mapping techniques for evaluating collagen and water (T2) or proteoglycan (T1ρ, dGEMRIC) content

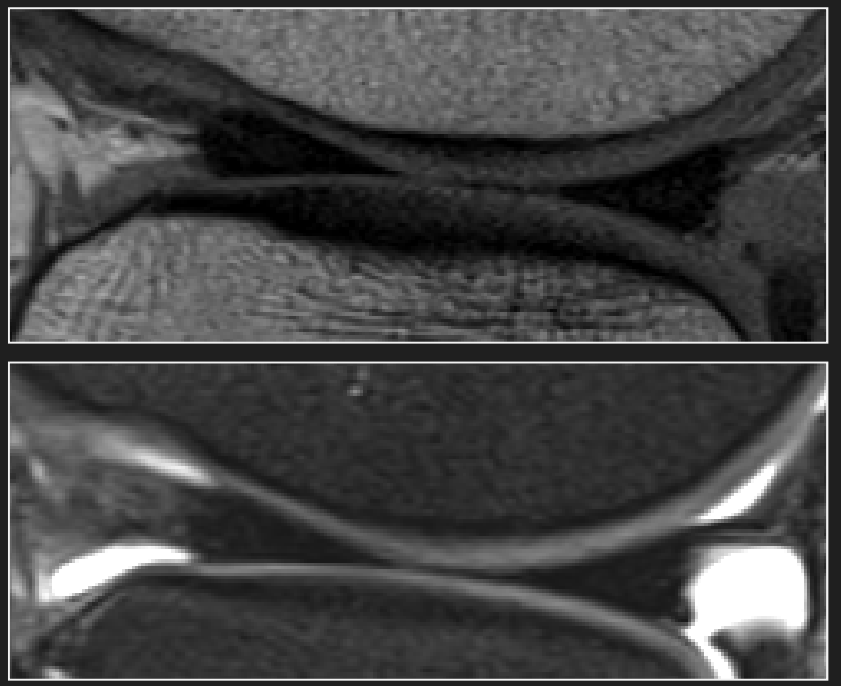
- Early lesion detection before morphological damage
- Post processing, standardization, reproducibility, specificity?



Apprich S et al (2010) Detection of degenerative cartilage disease: high-resolution MR and quantitative T2 mapping at 3T. Osteoarthritis and Cartilage 18;1211-1217

MR Imaging of the Osteochondral Junction

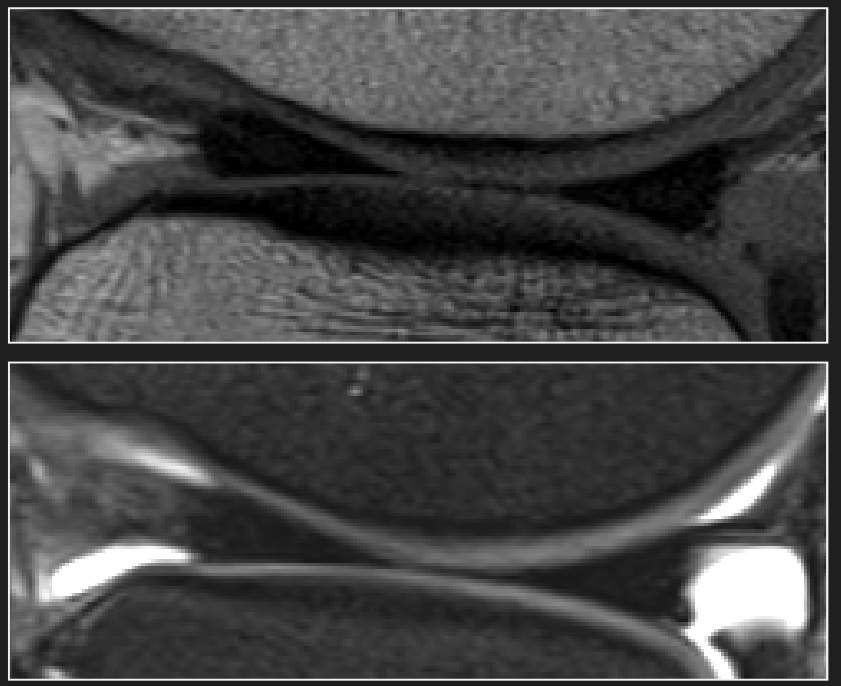
Conventional MRI unable to acquire data in the deep radial/calcified layer (T2<1ms).



TE=30-35ms

MR Imaging of the Osteochondral Junction

Conventional MRI unable to acquire data in the deep radial/calcified layer (T2<1ms). Overestimation depth cartilage lesions!



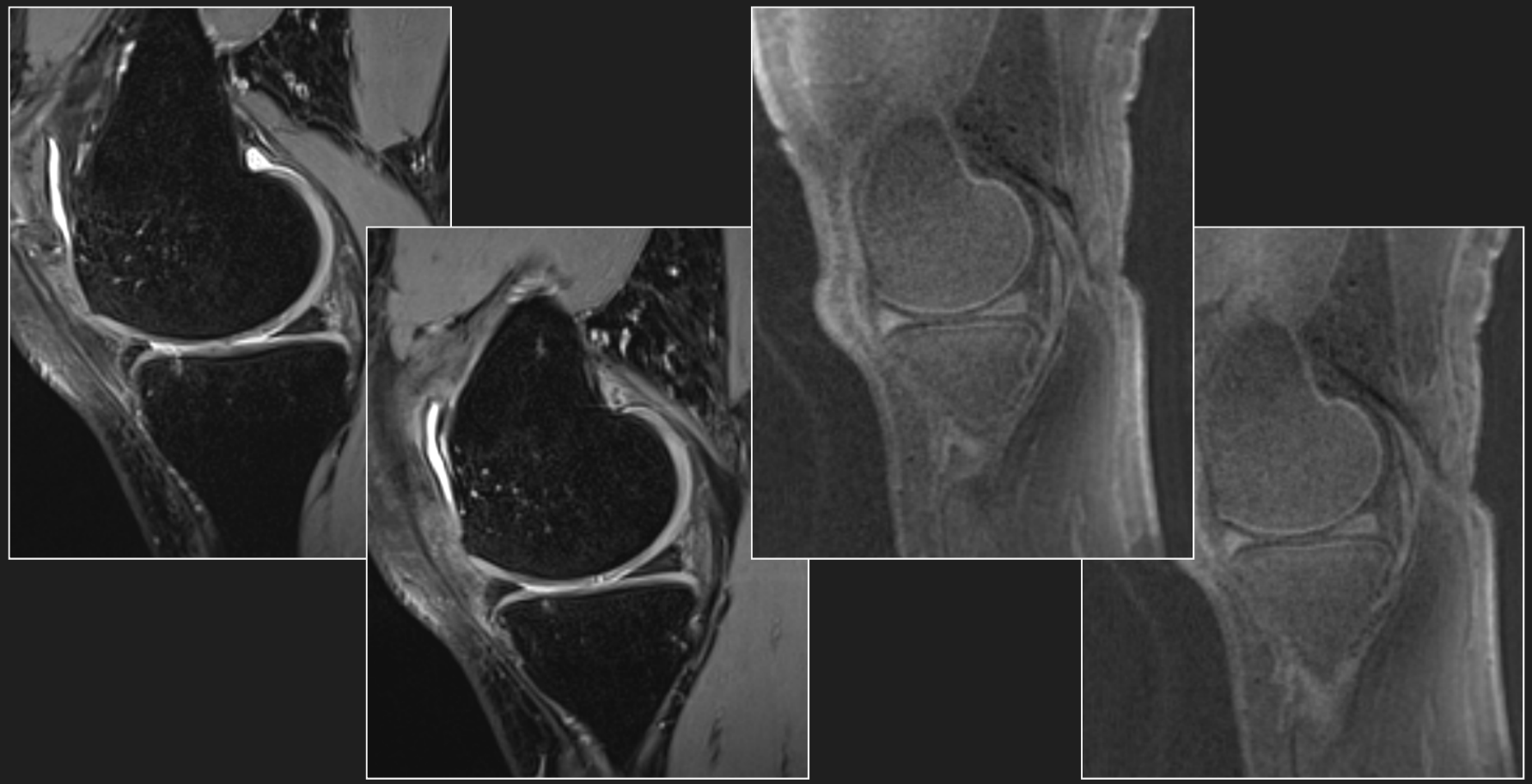
TE=30-35ms

Ultrashort Echo Time Imaging

UTE imaging enables direct visualization of deep layer by using μs TE

Ultrashort Echo Time Imaging

UTE role in grading articular cartilage lesions?



Ultrashort Echo Time Imaging

UTE role in meniscal imaging?

Thank You