# Clinical Relevance of Imaging in Osteoarthritis: The Radiologist's Perspective

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# Imaging: why is it relevant?

- Imaging is a powerful tool in OA assessment
- Morphology of different joint structures
- Function/composition of some structures
- Imaging improved the understanding of natural history and symptoms in OA

# Imaging - Overview

- Radiography
- Ultrasound
- Magnetic Resonance Imaging
- CT/CT-Arthrography
- Nuclear Medicine
- Others

# Radiography

- First line diagnostic imaging tool in a clinical setting
- Most of the time sufficient for clinical diagnostic purposes (OA); strongly associated with knee pain*
- X-ray detected joint space narrowing: only accepted imaging endpoint in clinical phase III trials (EMEA/FDA)
- Important for inclusion into clinical trials and subject stratification

*Neogi T et al. BMJ 2009;339:b2844

# Ultrasound

- Visualization of soft tissue structures in multiple planes
- Real time, mobile scanners, dynamic exam
- No radiation, inexpensive
- No contrast agent needed for synovial assessment
- Good soft-tissue contrast
- Most of the time sufficient for clinical diagnostic purposes (OA)

Keen HI, et al. Ann Rheum Dis. 2008 ;67:1116-20
Keen HI, Conaghan PG. Radiol Clin North Am 2009;47:581-94
Keen HI, et al. Ann Rheum Dis. 2009;68:611-9

# Ultrasound

- User-dependent
- Physical properties of sound limit its application
  - no visualization of subchondral bone and deep intra-articular structures!
- Low negative predictive value for cartilage assessment*
- Not yet validated as an outcome tool in OA**
- Documentation difficult (screenshots)

*Saarakkala S et al. Osteoarthritis Cartilage 2012 Feb 1 [Epub ahead of print]

**Keen HI et al. Ann Rheum Dis 2008;67:651-5

# Magnetic Resonance Imaging

- Tomographic technique; no radiation
- Multiplanar capability
- Superior tissue contrast
- High spatial resolution
- Clinically relevant for differential diagnosis*
- Direct visualization of all joint structures: whole-joint assessment

*Roemer FW et al. Osteoarthritis Cartilage 2009;17:1115-31

# Semiquantitative MRI Scoring Systems

- WORMS = Whole-Organ Magnetic Resonance Imaging Score
  Peterfy CG et al. Osteoarthritis Cartilage 2004;12:177-190
- KOSS = Knee Osteoarthritis Scoring System
  Kornaat PR et al. Skeletal Radiol 2005;34:95-102
- BLOKS = Boston Leeds Osteoarthritis Knee Score
  Hunter DJ et al. Ann Rheum Dis 2008;67:206-211
- SQ Synovitis Assessment Score
  Guermazi A et al. Ann Rheum Dis 2011;70:805-11
- MOAKS = MRI Osteoarthritis Knee Score
  Hunter DJ et al. Osteoarthritis Cartilage 2011;19:990-1002
- HOAMS = Hip Osteoarthritis MRI Score
  Roemer FW et al. Osteoarthritis Cartilage 2011;19:946-62
- OHOA-MRI = Oslo Hand Osteoarthritis MRI Score*
  Haugen IK et al. Ann Rheum Dis 2011;70:1033-8

***needs further validation**

# Semiquantitative MRI: Cartilage

- Sensitive to detect change over time
- Different baseline SQ grades = different risks of progression
- SQ grades extensively used as the outcome when testing different predictors
- Useful in identifying associations with clinically relevant lesions (BMLs)

Roemer FW et al. Osteoarthritis Cartilage 2011;19(Suppl 1):S165-6
Roemer FW et al. Osteoarthritis Cartilage 2011;19(Suppl 1):S162
Crema MD et al. Osteoarthritis Cartilage 2010;18(Suppl 2):S12

# Semiquantitative MRI
## Whole-organ Assessment

- **Direct assessment of other important articular structures:**
  - **Meniscus**
  - **Subchondral bone (BMLs and cysts)**
  - **Synovium (synovitis)**
  - **Synovial cavity (effusion)**
  - **Ligaments**
  - **Periarticular structures (bursae)**
  - **Loose bodies**

# Quantitative MRI

- **Cartilage (+++); sensitive to change**
- **May be applied in other joint structures** (menisci, bone, synovium)
- **Less observer dependent (more objective)**
- **Needs specialized software; time-consuming**
- **Less sensitive than SQ to small focal changes**


**Eckstein F et al. Radiol Clin N Am 2009;47:655-673**
**Buck RJ et al. Osteoarthritis Cartilage 2011;19:302-8**
**Wirth W et al. Magn Reson Med 2010;63:1162-71**
**Wirth W et al. Osteoarthritis Cartilage 2011;19:689-99**
**Fotinos-Hoyer AK et al. Magn Reson Med 2010;64:604-9**

# Compositional MRI

- **Detect alterations in cartilage matrix before surface damage** (collagen/water;GAG)
- **Special techniques required; some applicable on clinical scanners**
- **Needs segmentation (time-consuming)**
- **Prediction of incidence/progression of structural damage in OA: no strong evidence!**

**Burstein D et al. Radiol Clin N Am 2009;47:675-686**
**Link TM. Radiol Clin N Am 2009;47:617-32**
**Crema MD et al. Radiographics 2011;31:37-62**

# Compositional MRI

- T2 mapping
- dGEMRIC
- T1rho
- Sodium MR
- Diffusion

# Whole-organ MRI Assessment

- **Clinically relevant lesions in OA** (BMLs, synovitis, effusion)
- **Relevant lesions regarding progression of structural damage** (BMLs, meniscal damage, meniscal extrusion, effusion, cruciate tears)
- **Relevant non-MRI factors** (BMI, malalignment)
- **Natural history and intervention**

# Relevance of MRI Features in Progression of Structural Damage

- **Multiple studies have used cartilage loss as the outcome in longitudinal studies of knee OA**
- **Using quantitative and semiquantitative measurements, MRI based predictors are:**
  - **meniscal damage and extrusion [1-7]**
  - **bone marrow lesions [8-13]**
  - **pre-existing (focal) cartilage damage [14-16]**
  - **subchondral bone area/attrition [17,18]**
  - **ACL disruption [4]**
  - **effusion [12,19,20]**

1Hunter DJ et al. Arthritis Rheum 2006;54:795-801. 2Roemer FW, et al. Radiology 2009;252:772-80. 3Crema MD et al. Osteoathritis Cartilage 2010;18:336-43. 4Huétink K, at al. Radiology. 2010;256:536-46. 5Sharma L et al. Arthritis Rheum 2088;58:1716-26. 6Pelletier JP et al. Arthritis Res Ther 2007;9:R74. 7Ding C et al. Arthritis Res Ther 2007;9:R21. 8Hunter DJ, et al. Arthritis Rheum. 2006 Mar;54(3):795-801. 9Roemer FW, et al. Annals Rheum Dis. 2009;68:1461-5. 10Dore D et al. Arthritis Res Ther 2010;12:R222. 11Kothari A et al. Arthritis Care Res (Hoboken) 2010;62:198-203. 12Roemer FW et al. Arthritis Rheum 2011 Dec 27 [Epub ahead of print]. 13Wluka AE et al. Rheumatology (Oxford) 2008;47:1396-6. 14Ding C, et al. Arthritis Rheum. 2005;52(12):3918-27. 15Wluka AE, et al. Rheumatology.(Oxford) 2005;44(10):1311-6. 16Roemer FW et al. Osteoarthritis Cartilage 2011;19(Suppl 1):S162. 17Doré D, et al. Arthritis Rheum. 2010;62:1967-73. 18Neogi T et al. Arthritis Rheum 2009;15:1539-44. 19Hill CL, et al. Ann Rheum Dis. 2007 Dec;66(12):1599-603. 20Roemer FW et al. Ann Rheum Dis 2011;70:1804-9.

# Summary

- Multiple imaging tools available
- To date, MRI is the most important
- Associations between imaging findings and symptoms/fast progression/TKR
- Current therapeutic approaches have lapsed behind capabilities of MR imaging

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# Thank you!

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