

# KÕHREDE PATOLOOGIA RADIOLOOGILINE DIAGNOOS

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# RADIOLOOGILISED URIMISMEETODID

- Konventsionaalne röntgen
- Ultraheli
- KT
  - KT- artrograafia
- MRT
  - MRT- artrograafia
- Nukleaarmeditsiin ja hübriidkuvamine (SPECT/KT, PET/KT, PET/MRT jne)

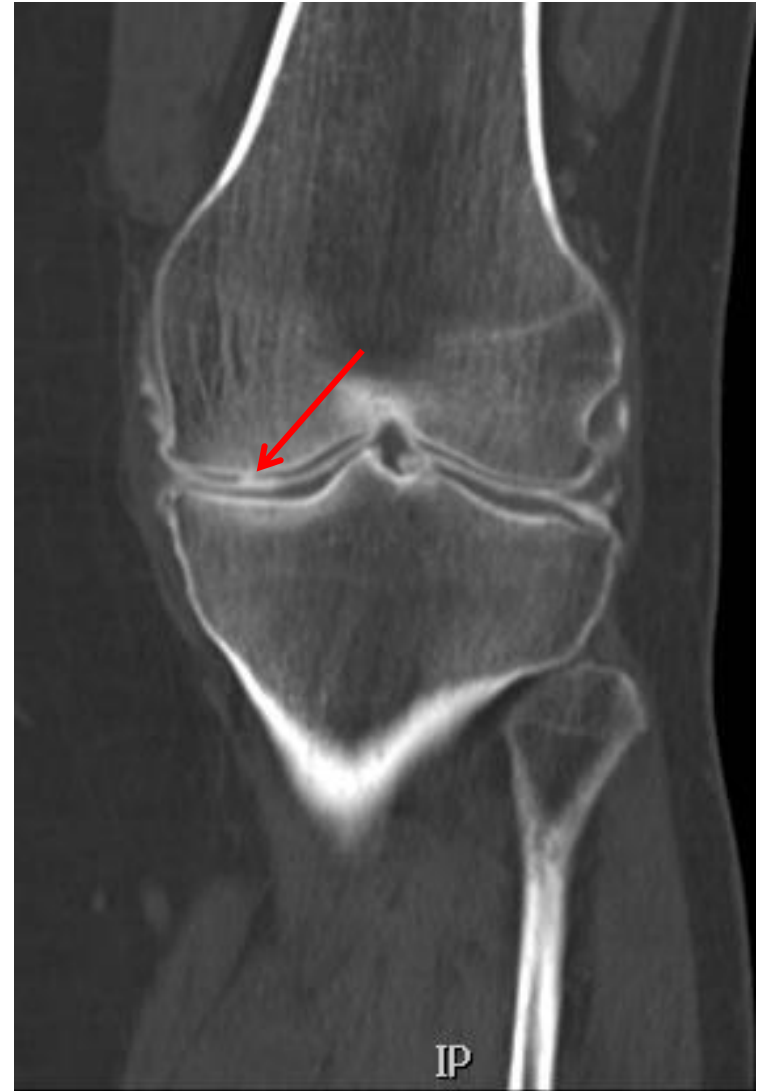
# KONVENTSIONAALNE RÖNTGEN ja KT

- Luustruktuuride ja/või lubjastuse hindamine
- Kõhrede patoloogia avastamiseks on vähe väärtuslik



# KT-ARTROGRAAFIA

- Kõhre välispinda hindamine
- Rebendi sügavus, defekti ulatus, delaminatsioon
- Ei saa hinnata:
  - Luuturset
  - Kõhre struktuuri muutust
- Varuvariant



# MRT



# MRT-ARTROGRAAFIA

- Üldjuhul ei ole näidustatud
- Lubab hinnata kõhre vigastuse olemasolu ning ulatus
- Piiratud roll kõhreravi järgsete muutuste hindamisel



# KLASSIFIKATSIOON

## (*OUTERBRIDGE* või *NOYES*'i järgi)

|                                                                                    | Grade | Macroscopy                                                   | MRI                                                                             |
|------------------------------------------------------------------------------------|-------|--------------------------------------------------------------|---------------------------------------------------------------------------------|
|    | 0     | Normal cartilage                                             | Normal cartilage                                                                |
|    | 1     | Rough surface;<br>chondral softening                         | Inhomogenous, high signal;<br>surface intact                                    |
|    | 2     | Irregular surface<br>defects; <50% of<br>cartilage thickness | Superficial ulceration, fissuring,<br>fibrillation; <50% of cartilage thickness |
|   | 3     | Loss of >50% of<br>cartilage thickness                       | ulceration, fissuring, fibrillation; > 50%<br>of the depth of cartilage         |
|  | 4     | Cartilage loss                                               | Full thickness chondral wear with<br>exposure of subchondral bone               |

# KLASSIFIKATSIOON



1.aste

2.aste



# KLASSIFIKATSIOON

3.aste



4.aste



M.D.Crema -  
<http://dx.doi.org/10.1148/rg.311105084>

G.E.Gold et al. AJR.2009;193: 628-638

# KÕHRED MAGNETVÄLJAS

- “TAVALISED” ehk MORFOLOOGILISED UURIMISMEETODID
  - Hinnatakse kõhrekoe terviklikus, rebendite ja defektide olemasolu ning ulatus
- “EBATAVALISED” UURIMISMEETODID ehk *COMPOSITIONAL IMAGING*
  - Uuritatakse kollageen võrku seisundi, veesisaldist ja/või glükoosaminoglükaanide sisaldist kõhres
  - Mõned meetodid kasutavad KA-t

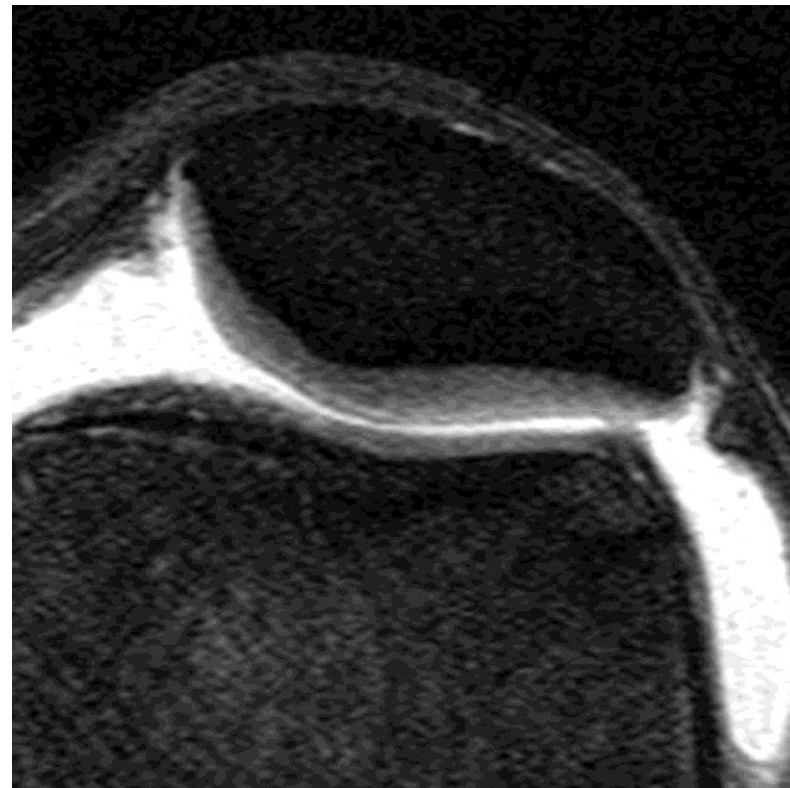
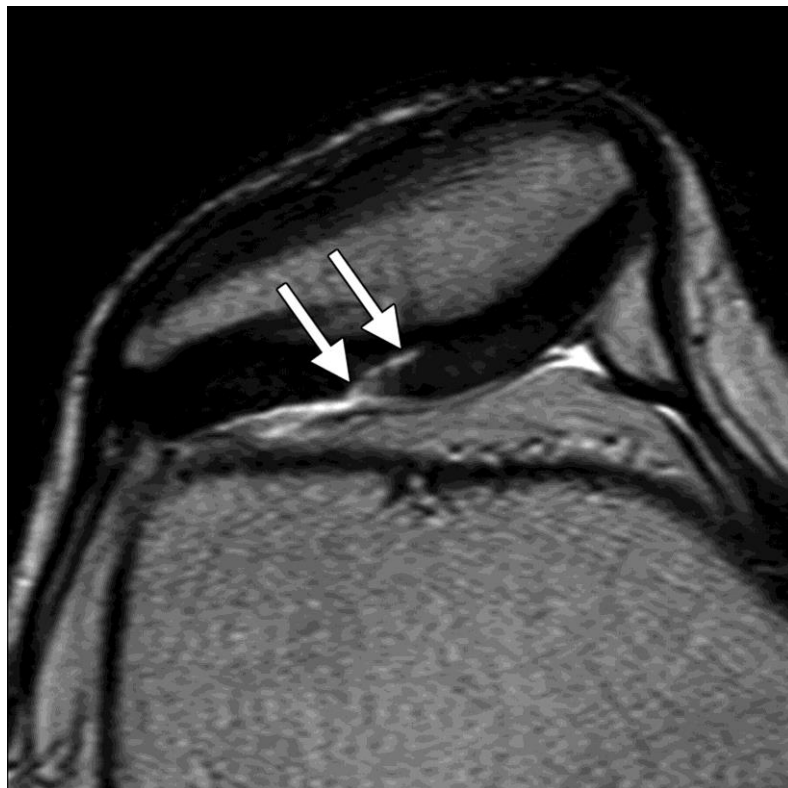
# MORFOLOGILISED UURIMISMEETODID

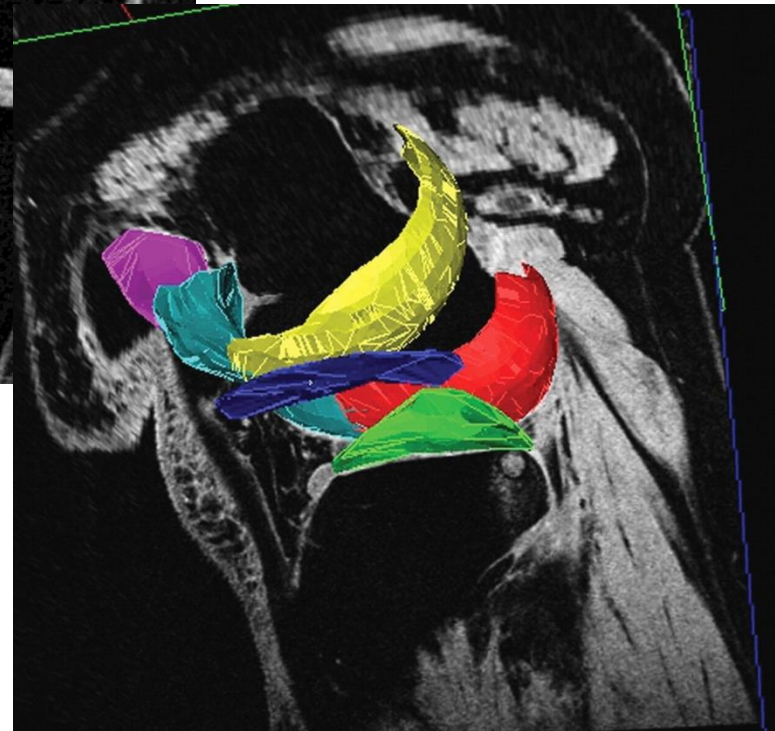
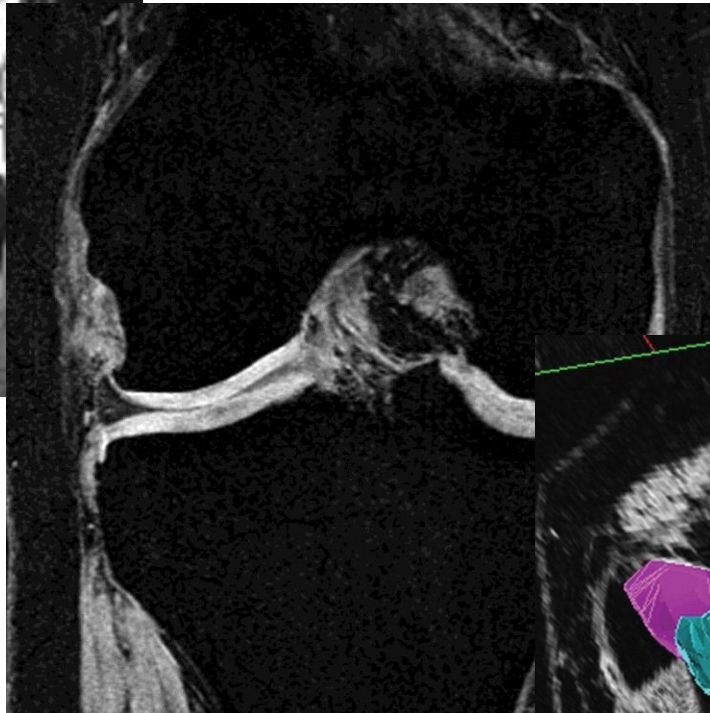
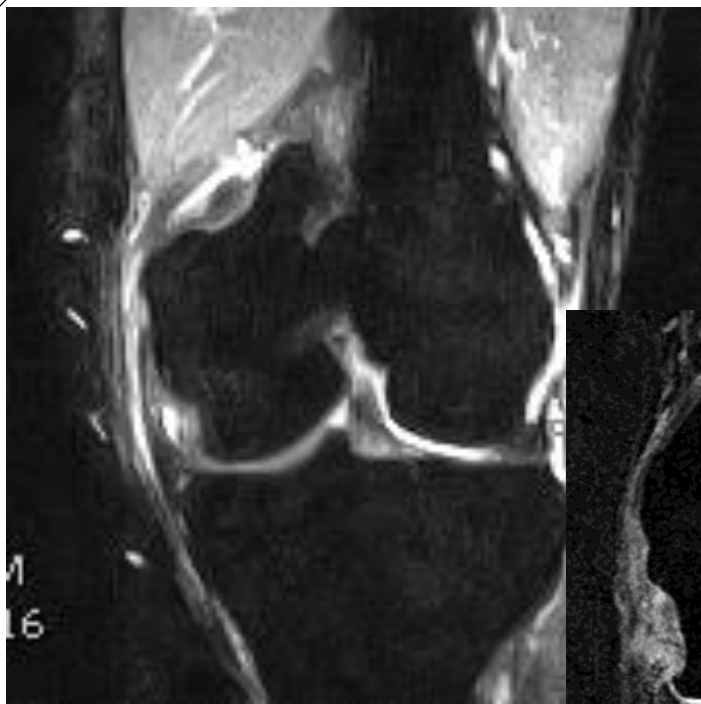
| MR Imaging Technique | Characteristics                                                                                                                                                                | Strengths                                                                                                                                                                            | Drawbacks                                                                                                                |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 2D fast SE           | Standard imaging technique used in clinical and research settings; includes T1-, T2-, intermediate-, and proton density-weighted sequences                                     | T2- and intermediate-weighted sequences provide excellent contrast between fluid and cartilage                                                                                       | Anisotropic voxels, section gaps, partial volume effects                                                                 |
| 3D fast SE           | Relies on flip-angle modulation to reduce blurring, parallel imaging to reduce time for acquisition of intermediate-weighted or proton density-weighted images                 | Isotropic voxels allow multiplanar reformatting of image data, decrease in partial volume artifacts                                                                                  | Has not yet replaced 2D fast SE in clinical practice                                                                     |
| 3D SPGR              | Spoils the transverse steady state by semirandomly changing the phase of the radiofrequency pulse; provides T1- or proton density-weighted contrast                            | Standard technique for 3D morphologic imaging, has higher sensitivity than routine 2D fast SE; isotropic voxels allow multiplanar reformatting, decrease in partial volume artifacts | Long acquisition times, lack of reliable contrast between fluid and cartilage, vulnerability to susceptibility artifacts |
| 3D DESS              | Two or more gradient echoes, each pair separated by a refocusing pulse, are acquired, and data from both are combined in image reconstructions; higher flip angles may be used | Allows shorter acquisition times than SPGR, high SNR, and high cartilage-to-fluid contrast; isotropic voxels allow multiplanar reformatting, decreased partial volume artifacts      | Unreliable depiction of signal intensity changes within cartilage, vulnerability to susceptibility artifacts             |
| 3D bSSFP             | Steady-state sequence similar to DESS but with different parameters; may be combined with a 3D radial <i>k</i> -space acquisition (VIPR)                                       | High SNR and cartilage-to-fluid contrast; isotropic voxels allow multiplanar reformatting, decreased partial volume artifacts                                                        | Long TR leads to banding artifacts, especially when high field strength (3.0 T) is used                                  |
| 3D DEFT              | Active return of magnetization to the z-axis after each excitation enhances the signal intensity of fluid while preserving that of cartilage                                   | Allows diagnostic performance comparable to that obtained with 2D fast SE and SPGR techniques                                                                                        | Long acquisition times, frequently insufficient fat saturation                                                           |
| 3D fast SE SPACE     | Large eligible turbo factors are used with a restore pulse and variable flip angle distribution to achieve a pseudo steady state                                               | Allows acquisition of isotropic voxels for multiplanar reformatting; has good SNR and high SNR efficiency                                                                            | Long acquisition times; insufficiently validated for clinical use                                                        |

# MORFOLOOGILISED UURIMISMEETODID

- Erinevad 2D- ja 3D-seeriad, tavaliselt koos rasvsuppressiooniga
- Erinev kihipaksus (0,5 mm kuni 5 mm)
- Erinev uuringuaeg

# MORFOLOGILISED UURIMISMEETODID





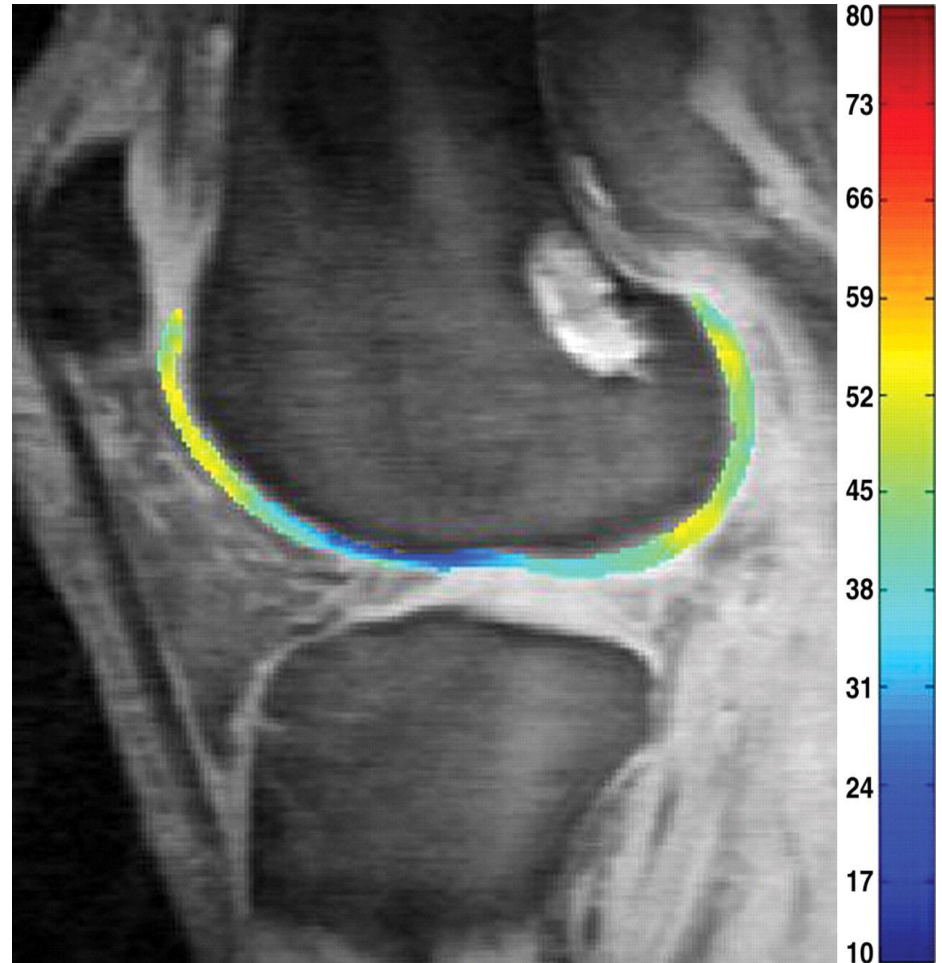
M.D.Crema -  
<http://dx.doi.org/10.1148/rg.311105084>

# COMPOSITIONAL IMAGING

| MR Imaging Technique       | Cartilage Component Assessed         | Strengths                                                                                                               | Drawbacks                                                                                                                                           | Tested in Clinical Trials |
|----------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| T2 mapping                 | Collagen network, water content      | Clinically useful, well validated, robust; does not require use of contrast material                                    | 2D technique, long acquisition time                                                                                                                 | Yes                       |
| dGEMRIC                    | Glycosaminoglycans                   | Measurements correlate indirectly with glycosaminoglycan content; clinically useful, well validated                     | Requires use of intravenous contrast material with time delay before acquisition                                                                    | Yes                       |
| T1ρ imaging                | Collagen network, glycosaminoglycans | Robustness, high sensitivity for detection of early degeneration; does not require use of contrast material             | Unclear specificity for assessing cartilage components; special pulse sequences must be applied; acquisition of multiple datasets is time consuming | No                        |
| Sodium imaging             | Glycosaminoglycans                   | Measurements correlate directly with glycosaminoglycan content; does not require use of contrast material               | Low SNR, low spatial resolution; requires use of special hardware                                                                                   | No                        |
| Diffusion-weighted imaging | Collagen network, glycosaminoglycans | Provides additional information about glycosaminoglycan and collagen content; does not require use of contrast material | Absolute quantification in thin cartilage layers is demanding                                                                                       | No                        |

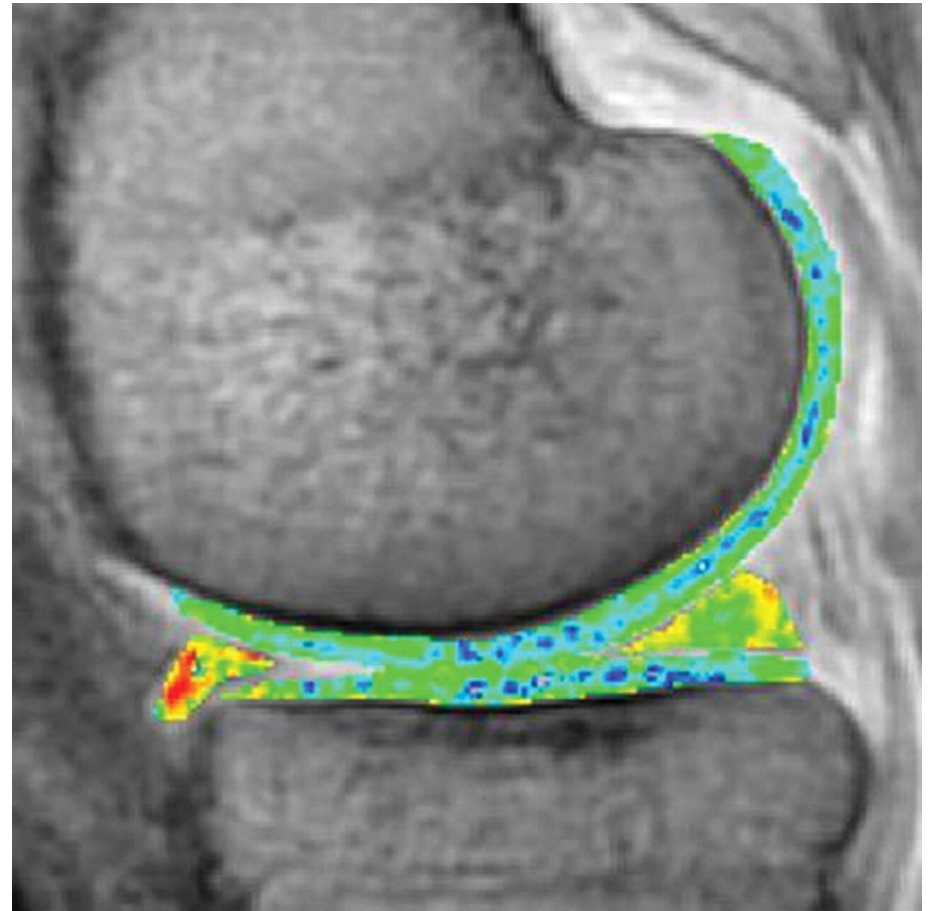
# T2-MAPPING

- NÄITAB  
VEEMOLEKULITE JA  
KOLLAAGEENI  
MAKROMOLEKULITE  
OMAVAHLIST  
INTERAKTSIOONI
- VÄGA TUNDLIK  
KÕHRE MATRIKSI  
MUUTUSTE SUHTES



# dGEMRIC

- Kasutab Gd-DTPA i/v kontrastainet
- Pikk uuringuaeg
- Aluseks on KA ioonide erinev kontsentratsioon sõltuvalt glükoosaminoglükaani de ioonide kontsentratsioonist



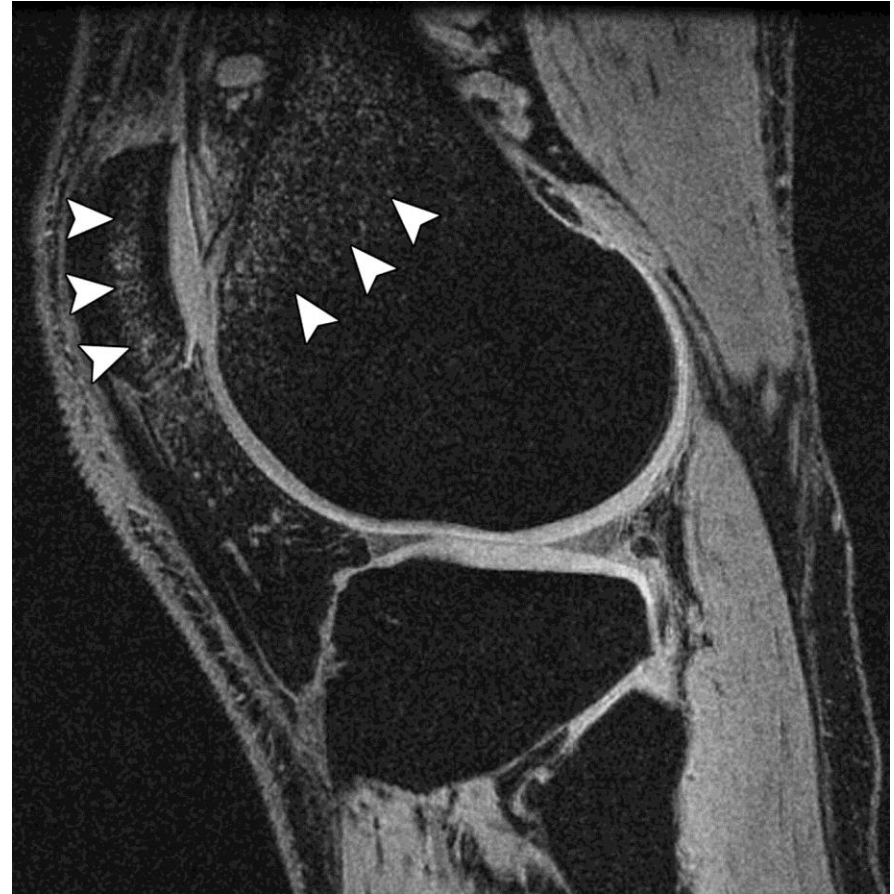
# MR VÄLJATUGEVUS ja KÕHR

- 0,18-0,2T – ei sobi kõhre hindamiseks
- 1T – piisavalt hea morfoloogiliseks hindamiseks
- 1,5T – väga hea morfoloogiliseks hindamiseks, võib teha ka *compositional imaging*
- 3T – väga hea kõikideks meetoditeks
- 7T – teadusuuringud, kliiniliselt lisaväärtust hetkel ei anna

3T

VS

7T



# PEDIAATRILINE KÕHR

Toruluudes on 3 kõhre – artikulaarne, epifüsaarne ning füsaarne

**TABLE 1: Modified Outerbridge Classification [19, 20] for Grading Chondral Lesions of the Knee With MRI**

| Grade | Description                                                      |
|-------|------------------------------------------------------------------|
| 0     | Intact articular cartilage                                       |
| 1     | Articular cartilage thickening with abnormal signal              |
| 2     | Superficial ulceration or fissuring                              |
| 3     | Deep ulceration or fissuring                                     |
| 4     | Full-thickness chondral injury with bruising of subchondral bone |
| 5     | Osteochondral injury with separation of osteochondral fragment   |

# PEDIAATRILINE KÖHR



M.M.Thapa et al. - AJR 2012;198: W450-W455

# KÕHRERAVI JA MRT

- Kõhrkoe lokaalne kasvu /luuüdi stimulatsioon (abrasioon, mikrofraktuuring, subkondraalluu puurimine jne)
- Kõhrkoe transplantatsioon
  - Autoloogne osteokondraalne transplantatsioon
  - Osteokondraalse allografti transplantatsioon
  - Autoloogne kondrotsüütide transplantatsioon
  - jne
- Tüvirakkude kasutamine

# MIKROFRAKTUURING



5 KUUD



# MIKROFRAKTUURINGU TÜSISTUS



Autoloogne  
osteokondraalne  
transplantatsioon



Autoloogne  
kondrotsüütide  
transplantatsioon



# TAKE OFFICE MESSAGE

😊 "TUNNE OMA KODUMAAD" 😊

