Susceptibility Artifacts In The Tibio-femoral Joint Space on 3T Knee MRI:

Frequency, Longitudinal Changes and Their Relation To Meniscal Tears, Radiographic Joint Space Narrowing and Calcifications

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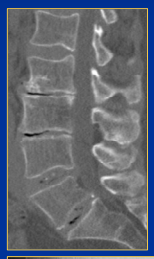
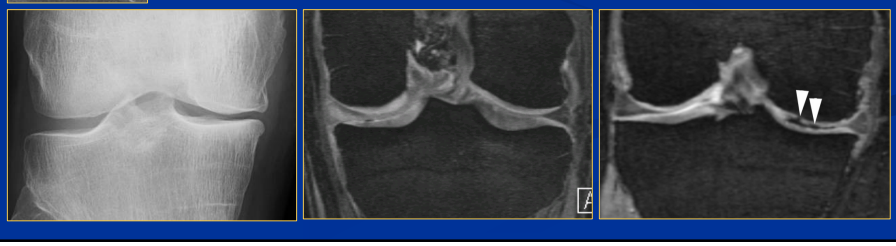
DISCLOSURES

- The Joints on the Glucosamine Study was supported by the research grant from the Coca-Cola Company Beverage Institute for Health & Wellness
- Ali Guermazi is President of Boston Imaging Core Lab (BICL) LLC. He is a consultant to AstraZeneca, Merck Serono, Genzyme, Novartis, and Stryker
- Frank W Roemer is Vice-President of BICL and is a consultant to Merck Serono and National Institute of Health
- Kent Kwoh is a consultant to Novartis and Pfizer

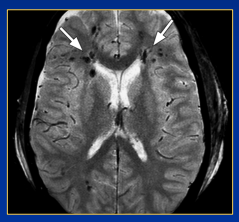
BACKGROUND: Susceptibility artifact (SA)



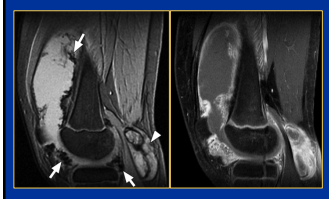
- Thought to represent vacuum phenomenon
- Seen on radiography, CT and MRI
  - may affect OA joints and vertebral discs
- On MRI, appears as linear or punctate hypointensities
  - commonly seen on gradient-echo (GRE) sequences
- In the TFJ of the knee, SAs appear adjacent to cartilage or menisci
- Cartilage assessment:
  - may be impaired due to signal loss
  - may result in false diagnosis of defects



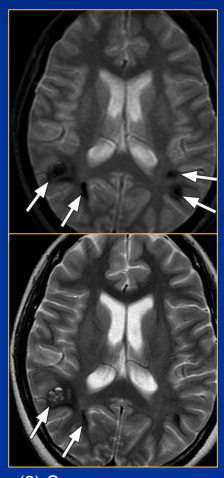
BACKGROUND: Susceptibility effect on MRI



(1) Diffuse axonal injury: periventricular microbleeding due to shear injury



(2) PVNS: synovitic hemosiderin deposits



(3) Cavernoma: T2* (=GRE) vs T2 FSE

- For diagnostic purposes magnetic susceptibility effects may be used to assess hemosiderin deposits e.g. in conjunction with
  - Traumatic hemorrhage (1)
  - PVNS (2)
  - Cavernoma (3)

Images from: Chavhan GB, et al. Radiographics. 2009 Sep-Oct;29(5):1433-49.

PURPOSE

- To assess the frequency of SAs in the TFJ space on two types of MR pulse sequences:
  - Dual Echo Steady State (DESS) = GRE
  - Intermediate-weighted (IW) turbo spin echo (TSE)
- To document the changes of SAs over 6-month period
- To assess associations of SAs with:
  - Intraarticular calcifications
  - Joint space narrowing (JSN)
  - Radiographic OA
  - MRI-detected meniscal damage in the medial and lateral TFJ

METHODS

- Subjects
  - 177 subjects aged 35-65 with chronic, frequent knee pain (WOMAC score ≥125 and ≤500)
    - Joints on Glucosamine Study Cohort
  - 346 knees
- Radiographic acquisition
  - PA fixed flexion knee radiographs were acquired at baseline
- MRI acquisition
  - MRI of each knee was performed at baseline and 6-month follow-up using a 3T MRI (Siemens Trio, Erlangen, Germany)

METHODS

- Radiographic interpretation
  - Semiquantitative scoring of JSN according to OARSI atlas
  - Kellgren-Lawrence grading
  - Presence of linear/punctate calcifications within the medial/lateral TFJ
- MRI interpretation
  - Meniscal damage (WORMS grade ≥1) at baseline
  - Presence of linear/punctate hypointensities representing SAs in the medial/lateral TFJ space at baseline and follow-up
    - coronal DESS
    - coronal IW

METHODS

- Reading of MR (DESS, IW) and XR images
  - Each read on separate reading sessions >2 weeks apart
  - All images were read blinded and in random order
- Concordance among findings on the baseline DESS, IW and XR
  - Simple kappa statistics
- Difference between knees with and without SA on DESS, in regard to:
  - Presence of meniscal tear in the ipsilateral compartment
  - Radiographic OA (KL grade ≥2)
  - Moderate or severe JSN (OARSI grade ≥2)

RESULTS

- Baseline demographic characteristics of the subjects
  Mean age: 52.3 (SD, ±6.2) years
  95 (53.7%) were men, 160 (90.4%) were white
  Mean BMI: 29.1 (SD ±4.1) kg/m^2
  KL grade ≥2 (worst knee): 126 subjects (71%)

Frequencies of SAs on MRI and calcifications on radiography

Table 1 (N = 346 knees)	Medial TFJ		Lateral TFJ	
	Baseline	F/u	Baseline	F/u
SAs on DESS	13 (4%)	12 (4%)	5 (2%)	3 (1%)
SAs on IW	4 (1%)	8 (2%)	1 (0.3%)	1 (0.3%)
Calcification on radiography	7 (2%)	N/A	14 (4%)	N/A

RESULTS

- Change of SAs between baseline and F/u

Table 2	Medial TFJ		Lateral TFJ	
	DESS	IW	DESS	IW
Present at baseline	**13**	**4**	**5**	**1**
Persistent at F/u	6	3	2	0
Absent at F/u	7	1	3	1
Incident at F/u	6	5	1	1

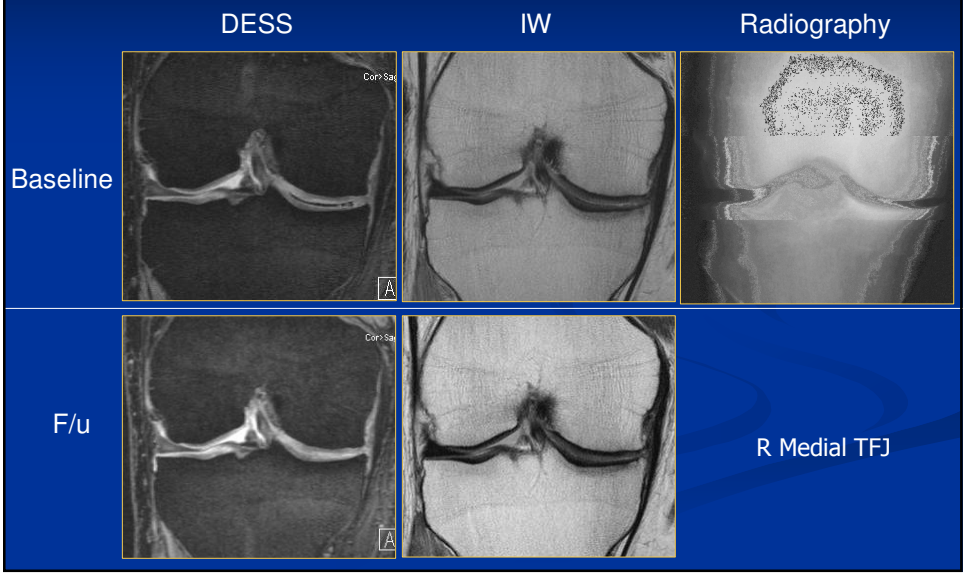
RESULTS

- Agreement between DESS and IW, and between DESS and radiography

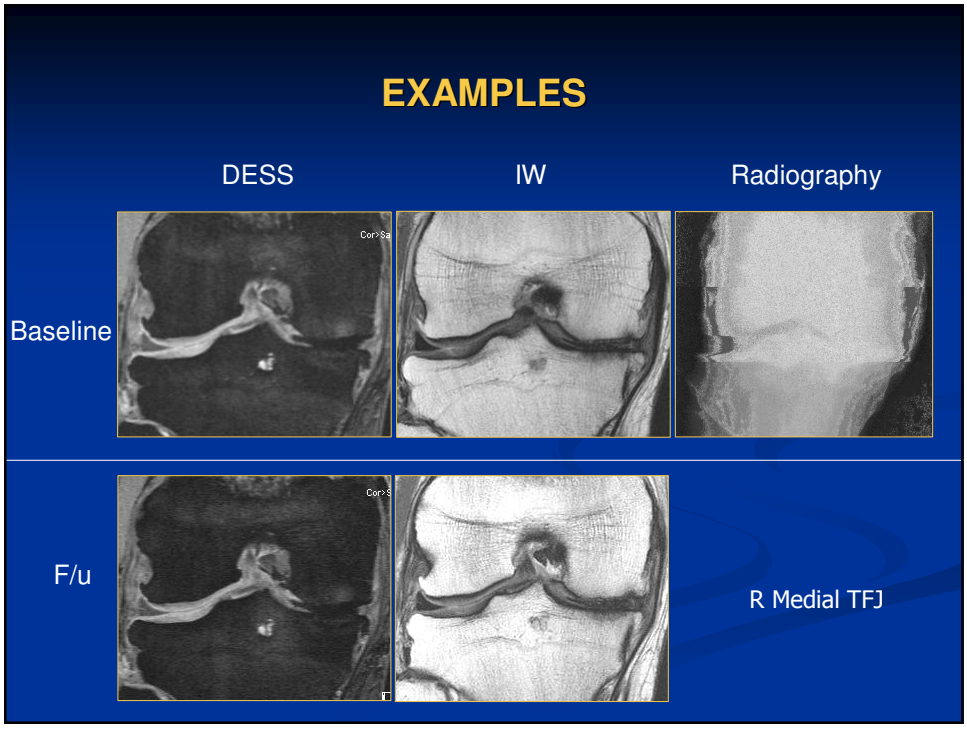
Table 3	Medial TFJ	
	Kappa	95%CI
DESS vs. IW (Baseline)	0.46	0.17, 0.75
DESS vs. Radiography (Baseline)	0.18	-0.06, 0.42

We could not calculate kappa in the lateral TFJ due to a very small number of SAs in the lateral compartment.

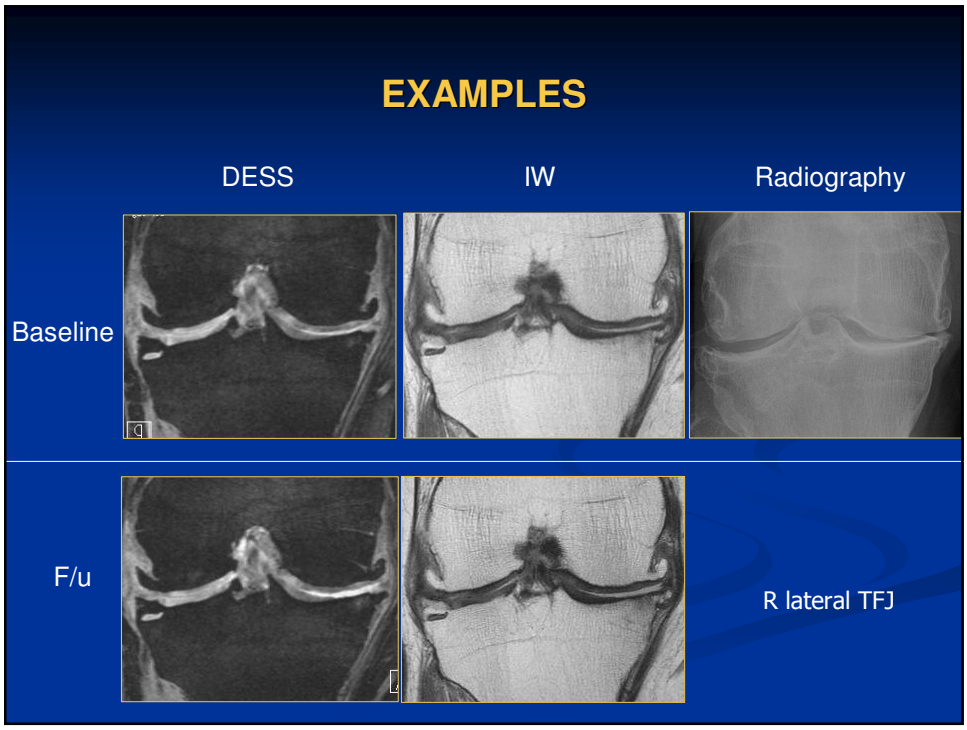
EXAMPLES



EXAMPLES



EXAMPLES



RESULTS

- Comparison between knees with and without SAs on DESS at baseline

Table 4	Medial TFJ			Lateral TFJ		
	SA(+) n=13	SA(-) n=333	P	SA(+) n=5	SA(-) n=341	P
Meniscal tear	9 (85%)	117 (35%)	**0.02**	1 (20%)	30 (9%)	-
Radiographic OA*	11 (85%)	199 (60%)	0.09	4 (80%)	206 (60%)	-
JSN†	5 (39%)	39 (12%)	**0.02**	1 (20%)	8 (2%)	-

*** KL grade ≥2** **† OARSI grade ≥2**

P-values were calculated using Fisher's exact test. We could not calculate p-values in the lateral TFJ due to a very small number of SAs in the lateral compartment.

CONCLUSIONS

- SAs on GRE sequence in the TFJ:
  - rarely correspond to radiographic calcifications
  - commonly show longitudinal changes

    → Support the hypothesis that SAs represent vacuum phenomenon
- SAs in the medial TFJ:
  - more frequently seen in knees with medial meniscal tears and moderate to severe medial JSN

    → Suggests an association with more advanced OA-related joint damage
- Researchers need to be aware of SAs when reading MRI of OA knees