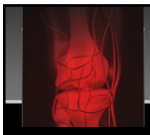
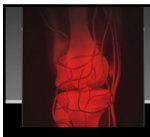


Quantitative Bone Marrow Lesion Changes Relate to Cartilage Parameter Changes: Data From the Osteoarthritis Initiative

Driban JB, Pang J, Miller E, Destenaves G, Lo GH, Ward RJ, Price LL, Eaton CB, McAlindon TE

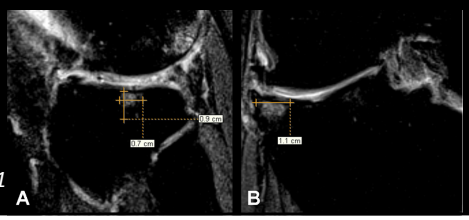
Jeffrey B. Driban, PhD, ATC, CSCS
Division of Rheumatology
Tufts Medical Center
July 12, 2012

No authors have professional or financial affiliations that would bias this work.

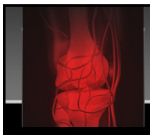


Introduction

- Bone marrow lesions (BMLs)
  - Common MR imaging findings in osteoarthritis
  - Related to cartilage integrity
- We previously[1] did not detect a relationship between changes in BML size and cartilage morphometry
  - A secondary analysis of a clinical trial
  - Used an approximate measure of BML size

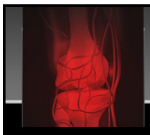


1. Driban JB et al., 2011



Objective

- The purpose of this study was to assess the relationship between quantitative 3-dimensional assessments of BML volume and quantitative cartilage morphometry in a cohort from the Osteoarthritis Initiative.
- This was a validation step of a new semi-automated BML segmentation method.



Participants

4,796 OAI participants

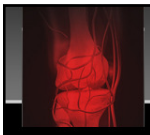
↓

732 knees with cartilage segmentation
(0- and 24-month visits)

↓

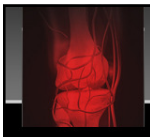
196 knees with full thickness cartilage loss (denuded area) on the tibia and femur in the index compartment
(defined as the tibiofemoral compartment with greater denuded area)

kmri_qcart_eckstein00 [version 0.4], kmri_qcart_eckstein03 [version 3.3]



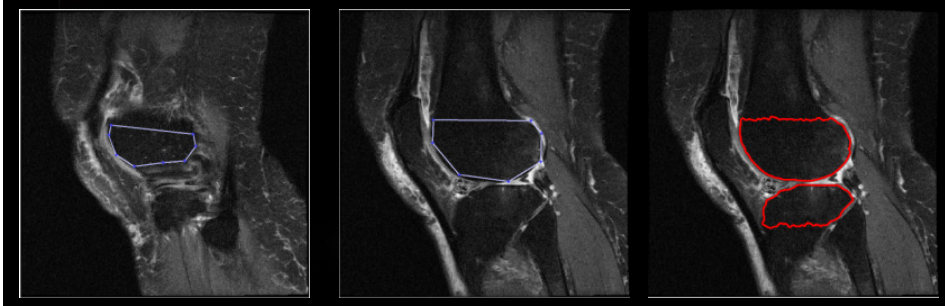
Participants

- 20 knees w/ a medial tibiofemoral index compartment
- 20 knees w/ a lateral tibiofemoral index compartment
  - n = 5 had the least change in femur denuded area
  - n = 5 had the greatest change in femur denuded area
  - n = 5 had the least change in tibia denuded area
  - n = 5 had the greatest change in tibia denuded area
- These selection criteria were intended to provide a diverse range of denuded area change
- Power computation ($r > 0.40$, *power* > 0.80, $\alpha_2 < 0.05$)



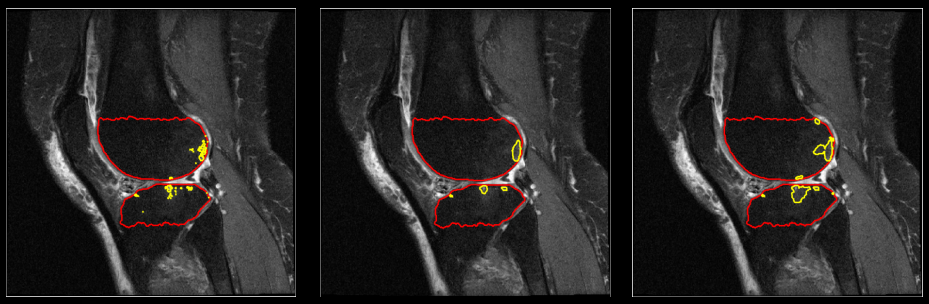
BML Volume Measurements

- Sagittal intermediate-weighted, turbo spin echo, fat-suppressed MR images
- One rater (ICC [3,1 model] = 0.79 to >0.99)



OAI images are publicly available: http://oai.epi-ucsf.org

BML Volume Measurements



- Variables of interest
  - Change in tibia BML volume (mm^3; index compartment)
  - Change in femur BML volume (mm^3; index compartment)

Cartilage Parameters

- Sagittal DESS sequences
  - 2 knees: coronal FLASH water excitation
- Manual segmentation of cartilage
- Part of the OAI public datasets
  - kmri_qcart_ecksteinXX [version 0.4, 3.3]
- Variables of interest
  - Changes in tibia cartilage thickness (mm)
  - Changes in central femur cartilage thickness (mm)
  - Changes in tibia denunded area (%)
  - Changes in central femur denuded area (%)

Statistical Analyses

- Change = 24-month data – baseline data
- Spearman correlation coefficients
- All analyses were limited to the index compartment

Descriptive Data (n = 38)

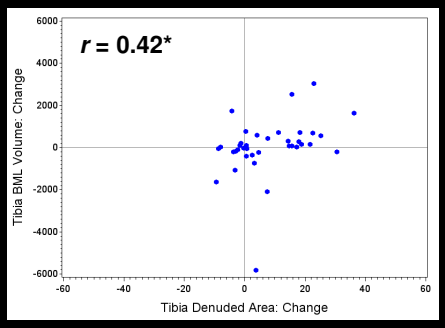
	Mean ± SD n (%)
Females	25 (66%)
Progression Cohort Members	36 (95%)
Kellgren-Lawrence Grade $\geq$ 2	38 (100%)
Age (years)	61 ± 8
Body Mass Index (kg/m^2)	29.9 ± 5.3
Central Femur Cartilage Thickness: Change (mm)	-0.24 ± 0.32
Central Femur Denuded Area: Change (%)	11.2 ± 17.3
Tibia Cartilage Thickness: Change (mm)	-0.14 ± 0.20
Tibia Denuded Area: Change (%)	7.6 ± 11.6
Femur BML volume change (mm^3)	273 ± 1239
Tibia BML volume change (mm^3)	51 ± 1354

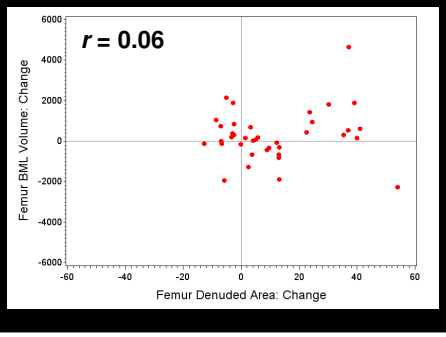
Associations: ΔBML – ΔCartilage

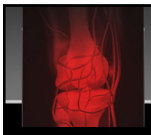
	Femur BML Volume: Change (n = 38)	Tibia BML Volume: Change (n = 38)
Central Femur Cartilage Thickness: Change	-0.13	-0.30
Central Femur Denuded Area: Change	0.06	0.35*
Tibia Cartilage Thickness: Change	-0.15	-0.46*
Tibia Denuded Area: Change	0.15	0.42*

*Note: * p < 0.05. Spearman Correlation Coefficients.*

Associations: ΔBML – ΔCartilage

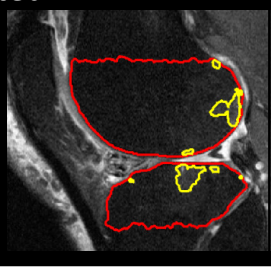


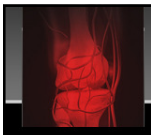




Discussion

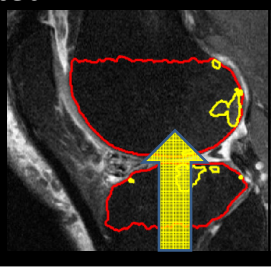
- Local bone and cartilage changes
  - Tibial BML change – tibial +femoral cartilage change (related)
  - Femoral BML change / femoral cartilage change
  - Not addressing causality
- Construct validity for this semi-automated BML segmentation approach
  - Good reliability
  - Time efficient: 4 to 12 minutes

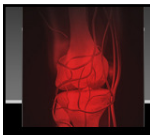




Discussion

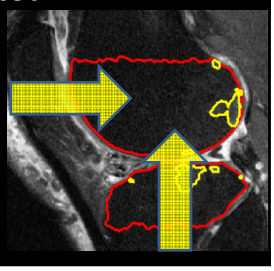
- Local bone and cartilage changes
  - Tibial BML change – tibial +femoral cartilage change (related)
  - Femoral BML change / femoral cartilage change
  - Not addressing causality
- Construct validity for this semi-automated BML segmentation approach
  - Good reliability
  - Time efficient: 4 to 12 minutes

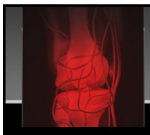




Discussion

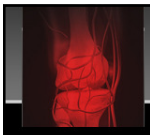
- Local bone and cartilage changes
  - Tibial BML change – tibial +femoral cartilage change (related)
  - Femoral BML change / femoral cartilage change
  - Not addressing causality
- Construct validity for this semi-automated BML segmentation approach
  - Good reliability
  - Time efficient: 4 to 12 minutes





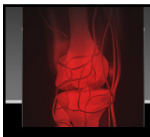
Limitations

- Associations among knees with denuded area
- Construct validity
  - Validation may be specific to MR scanners and sequence
  - Additional validation warranted when applied to new studies



Conclusions

- Among participants with knee OA and denuded areas of cartilage an increase in tibia BML volume is associated with longitudinal tibia and femur cartilage loss.
- Significant associations in the tibia and not the femur may be a result of the entire tibia cartilage being assessed while only the weight-bearing region of the femur was evaluated (omitting the patellofemoral region.



Thank You.

- *This study was funded by NIAMS (Grant number 1R01AR054938 to Timothy E. McAlindon).*
- *The OAI is a public-private partnership comprised of five contracts funded by the National Institutes of Health. Private funding partners include Merck Research Laboratories; Novartis Pharmaceuticals Corporation; GlaxoSmithKline; and Pfizer, Inc.*
- *This work was supported in part by the Houston VA HSR&D Center of Excellence (HFP90-020). The views expressed in this article are those of the author(s) and do not necessarily represent the views of the Department of Veterans Affairs.*