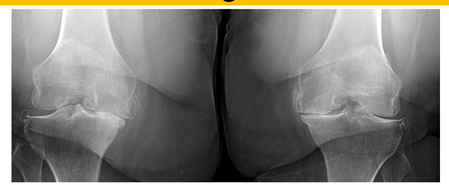
The QIBA MSK Biomarker Committee

MR-based cartilage compositional biomarkers (T1ρ, T2) for risk prediction, early diagnosis and monitoring of treatment of degenerative joint disease

Quantitative Imaging Biomarkers Alliance RSNA

Background



- Osteoarthritis is a major health concern for our aging population.
- Most frequent cause of disability in individuals older than 55 years (National Center for Health Statistics, 2009).
- Devastating impact on mobility and professional activity.
- Biomarkers for better risk assessment, diagnosis at early stages, and monitoring of osteoarthritis will have a significant impact on public health.

Cartilage MRI Biomarkers

Medial Femur T2 [ms] 30.82 | Medial Femur T2 [ms] 37.66 | Medial Femur T2 [ms] 42.30

- T1ρ and T2 cartilage compositional biomarkers provide information on cartilage quality before cartilage tissue is lost.
- May predict risk of developing Osteoarthritis, ➔ life style changes.
- Allow to monitor interventions.

Goals and Claims

Development and dissemination of technical performance standards for compositional cartilage imaging biomarkers

Preliminary Claims

- Cartilage matrix composition reflected by the T2 and T1ρ relaxation time values is measurable with MRI at 3T with a within-subject coefficient of variation of 4-5%.
- A measured increase in T2 and T1ρ of 11-14% or more indicates that a true/critical change has occurred with 95% confidence.

Profile Development

Claim → Standard MRI Acquisition → Standard Image Analysis → Conformance Devices and Analysis Software

Establish Claims.

Profile details include standardized subject handling, image data acquisition, and analysis.

Need to establish Quality Control criteria.

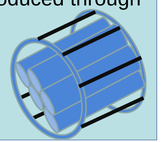
Conformance specifications include image acquisition sites, MRI devices, reconstruction software, and hardware.

Update and Current Groundwork Projects

➢Calibration Phantom Project

To develop dedicated phantoms for calibrating measures of morphology and composition of MSK tissues (e.g. articular cartilage), and for MSK coils.

Phantoms with different concentrations of agarose gel have been developed at UCSF and used for an Arthritis Foundation-sponsored multi-site study (UCSF, HSS, Mayo). Phantoms with the same design have been produced through the GE/NBA project and Phantom Lab. These phantoms will be used in the GE/NBA project at different sites and in an Arthritis Foundation Cross Calibration study.

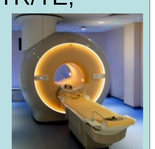


➢Standardized MRI Protocol

To establish an **MRI protocol** which can be used across different scanners and vendors.

The QIBA MSK biomarker committee will work on standardizing protocols of cartilage T2 and T1ρ mapping on three MR systems (GE, Siemens, Philips) regarding acquisition sequences (gradient echo-based vs spin-echo based), spatial resolutions, TR/TE, bandwidth and other parameters.

The current focus of the QIBA committee is also on **quality assurance** and recommendations concerning **subject selection** and **handling**.



➢Multi-Vendor Multi-Center Study

Initial results

A **cross-calibration study** has been funded by the Arthritis Foundation (Cleveland Clinic, UCSF, University of Kentucky, Albert Einstein College of Medicine).

3D T1ρ and T2 mapping techniques based on magnetization-prepared angle-modulated partitioned k-space spoiled gradient echo snapshots (MAPSS) acquisition have been developed on Siemens, GE and Philips platforms.

Intra-site scan/rescan RMS-CVs of T1ρ and T2 values ranged 1.1% - 3.1% and 1.7% - 3.6% for phantoms; they ranged from 1.0 - 4.9% and 1.0 – 4.0% for human subjects, respectively, suggesting excellent in vivo reproducibility

Inter-site variation of T1ρ and T2 values ranged from 3.2 - 5.1% for phantoms and 1.8% - 12.6% in human subjects (traveling volunteers).

➢Next steps and how you can participate

1. Obtain funding for a larger scale cross-calibration study.
2. Work with NIST (National Institute of Standards and Technology) on developing an MSK calibration phantom.

Contact the Co-Chairs at QIBA@rsna.org.

- Thomas M. Link, MD, PhD (UCSF)
- Xiaojuan Li, PhD (Cleveland Clinic)

References: **(1)** Schneider E et al. Osteoarthritis Cartilage. 2013 Jan;21(1):110-6, **(2)** Mosher TJ et al. Radiology. 2011 Mar;258(3):832-42, **(3)** Li X et al. Osteoarthritis Cartilage. 2015 Dec;23(12):2214-2223, **(4)** Li X et al. *J Magn Reson Imaging*. 2014 May;39(5):1287-93 and **(5)** MacKay J et al. Osteoarthritis Cartilage. 2018 Sep;26(9):1140-1152

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