QIBA Musculoskeletal (MSK) Biomarker Committee (BC) Call

Tuesday, October 16, 2018 at 10 AM CT

Call Summary

In attendance			**RSNA**
Xiaojuan Li, PhD (Co-Chair)	Ali Guermazi, MD, PhD	Ramya Srinivasan, MD	Joe Koudelik
Thomas Link, MD, PhD (Co-Chair)	Peter Hardy, PhD	Carl Winalski, MD	Susan Stanfa
Angie Botto-van Bemden, PhD	Yuxi Pang, PhD	Cory Wyatt, PhD	
Robert Boutin, MD	Mark Rosen, MD, PhD		

Moderator: Dr. Link

Arthritis Foundation Calibration Study Activities (Dr. Li)

- Dr. Li provided an update on the Arthritis-Foundation-sponsored, multi-site, multi-vendor cartilage T1rho and T2 quantification effort
- Most phantom and clinical data have been collected and results will be reported back to the MSK BC membership when they are ready to be presented
- ISMRM abstract is being prepared based on study results

Impact of temperature on T1, T1rho and T2 (Dr. Hardy)

- Phantom T2 measurements are sensitive to seasonal temperature fluctuations which may impact T2 values as well as the detection electronics or overall power levels into the various system components
- As a side project, temperature effects on T1rho measurements were investigated

[Some information after this point was taken from Dr. Hardy's slides]

- The problem
    - In multi-center, multi-site T1rho measurements variations in T1rho from site-to-site were noticed
    - Measurements were acquired in the summer during a period when A/C was used
    - In the University of Kentucky, housed in a basement, ambient temperature was very low
    - Staff wondered whether variations in T1rho resulted from variations in temperature of the phantom

- Changing the temperature of the phantom
    - Tubing was wrapped around the phantom and it was insulated with bubble wrap
    - Temperature-controlled chilled water was circulated through tubing to exchange heat with the phantom
    - The phantom contained a built-in thermometer for ongoing monitoring of the temperature

- Temperature of the phantom was measured before and at the conclusion of each imaging session
    - Scanning was performed across a range of phantom temperatures (3 to 27 degrees Celsius)
    - Temperature dependence of T1 observed; larger variation seen with increasing temperature with a linear correlation
    - Temperature dependency the opposite with T2; as temperature increased, measurement variability decreased
    - T1rho shows similar behavior as T2

- Published work on this topic to compare current findings
    - T1 variability with temperature change
        - Vassiliou VS, et al. **Magnetic resonance imaging phantoms for quality-control of myocardial T1 and ECV mapping: specific formulation, long-term stability and variation with heart rate and temperature**. *J Cardio Magnetic Resonance*. 2016; 18(1):62.
        - "Temperature sensitivity testing showed MOLLI T1 values in the long T1 phantoms increasing by 23.9 ms per degree increase and short T1 phantoms increasing by 0.3 ms per degree increase."

    - Gore JC, et al. **NMR Relaxation of water in hydrogel polymers: a model for tissue**. *Magnetic Resonance in Medicine*. 1989; 9(3):325-332.
    - Nelson TR, et al. **Temperature dependence of proton relaxation times in vitro**. *Magnetic Resonance Imaging.* 1987; 5(3):189-99.
        - Temperature dependence coefficient (TDC) measured at 0.15 T.
        - TDC of T1 for CuSO4~ 2.37%/degrees Celsius
        - TDC of T2 relatively small

- Implications for future work
    - Suggested that future phantoms have either (or both) a built-in thermometer and temperature control system
    - Phantom may be modelled after the NIST diffusion phantom

- Implications for the current MSK BC phantom study were discussed
    - Temperature contributed significantly to variation found in the data, causing true variation to be obscured
    - Possible solutions for controlling for temperature variation were discussed e.g., use of a water bath
    - Suggestion to develop calibration formula and provide guidance to mitigate measurement error due to temperature
    - Measurement may not need to be standardized in human subjects since body core temperatures can vary
    - Differences between phantom and human subject measurements need to be recognized
    - Cartilage temperature assumed to be similar to body core temperature
    - Discussion on variation in temperature of knee cartilage and how it would be measured; only minimal variation among subjects was estimated
    - In addition to calibrating the phantom, suggestion to ask subjects to place knee in a temperature-controlled device
    - After study is completed, Dr. Li to send the phantom back to Dr. Hardy for additional study on higher phantom temperatures, e.g., near the human core range

- Dr. Hardy to consider extending temperature measurements to a higher range including body temperature to allow better comparison of in vivo temperatures from site-to-site

MSK Profile (Dr. Link)

- RSNA staff explained next steps after the 1st draft of a Profile is completed which can be found on QIBA Wiki at: http://qibawiki.rsna.org/index.php/Public_Comment_Process
- Those with suggestions for changes and additions to the Profile sections being drafted are welcome to email Dr. Link

- Help with Section 3.6: Image Data Acquisition was requested
    - Standardized T1rho and T2 sequences needed – MAPSS T1rho and T2 mapping were developed on GE, Siemens and Philips platforms through the Arthritis Foundation multi-vendor multi-site study, and are recommended.
    - Standardized high-resolution morphologic sequences are needed for cartilage segmentation. Gradient echo based sequences: SPGR (GE)/DESS (Siemens)/FEE (Philips) are recommended.
    - Information from 2006 Dr. Guermazi study that compared DESS and SPGR -3% differences in volume to be used and referenced in the Profile

- Section 3.6: Image Data Acquisition
    - Will need to work closely with vendors to address intervendor variation initially calculated at 10%
    - Different sequences used by vendors will be an issue for clinical trials (drug development) and for clinical application; quantification needed to more accurately assess disease progression
    - Discussion regarding application of image segmentation in clinical trials vs. clinical practice. For clinical trials, normally centralized data processing (including cartilage segmentation) will be performed. Therefore reliable quantification from the central processing lab is required. For future clinical practice, vendors need to be engaged to implement automatic segmentation and processing methods on the scanner, ideally standardized methods.
    - A table of best sequences was suggested for the Profile
    - Discussion on this section to continue during the November 20 MSK BC call

- Section 3.7: Image Data Reconstruction changed to "Image Data Analysis"

OARSI imaging discussion group in Toronto

- The preliminary meeting program was discussed during a recent phone conference; the following topics were proposed:
    - Imaging in the clinic
    - Low value care
    - High value MRI
    - Defining early disease criteria
    - Imaging of early arthritis

2018 RSNA Annual Meeting & QIBA Kiosk

- Last year's poster to be used as a template
- To include new Arthritis Foundation study data
- Deadline for submitting a print-ready poster to RSNA Staff is Oct 31
- All are encouraged to RSVP for the QIBA Working Meeting on Wednesday, November 28th, 2 – 6 pm
- All are invited to volunteer for the poster Meet-the-Expert session times

Next Call: Tuesday, November 20th at 10 AM CT [regular time slot]

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