Talk Title: Quantitative UTE Techniques

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Educational Session: UTE & Zero TE Imaging Techniques & Applications (combined educational and scientific course)

Overview:

- Ultrashort TE (UTE) pulse sequences are able to detect very rapidly decaying signals from tissues with very short T2 or T2* relaxation times.
- The ability to extract quantitative data from UTE pulse sequences is limited due to:
    - Low signal-to-noise ratio (SNR) relative to other MRI techniques:

      SNR in MRI images varies with square root of the time spent sampling the signal. When the signal decays very rapidly, the time spent sampling the signal is correspondingly smaller, leading to low relative SNR.
    - Significant T2 blurring: the rapid signal decay of short T2 (or T2*) tissues can introduce significant signal decay even across very short sampling windows, exacerbating T2 blurring. This T2 blurring varies across short T2 tissues, making the absolute signal level somewhat less reliable.
- Nevertheless, a variety of quantitative and semi-quantitative techniques are beginning to emerge based on UTE pulse sequences. These include sequences for:
    - T2* mapping of tissues with ultrashort T2*;
    - Spectroscopic imaging based on multiecho interleaved variable TE UTE acquisitions;
    - UTE T1-rho mapping;
    - Quantitative extraction of proton density and bound- and free-water fractions from UTE images;
    - Bi-component T2* mapping of ultrashort T2* tissues.
- Emerging applications of quantitative and semi-quantitative UTE imaging include:
    - Spectroscopic imaging of the short T2 tissues in the musculoskeletal system;
    - Quantification of MR parameters from joint discs;
    - Extraction of MR parameters from tissues with rapidly decaying MR signal such as menisci, tendons, ligaments, entheses, and cortical and trabecular bone;
    - Assessment of deep subsurface cartilage and meniscus matrix changes in meniscus and tendons;
    - Separation of air and bone in MR images for creating synthetic CT from MRI to support radiation oncology workflow;
    - Quantitation of bound and free water fractions in cortical bone;
    - Quantitative morphological assessment and T2* mapping of meniscal calcifications;
    - Exploration of early biochemical changes in articular cartilage, such as assessment of collagen organization, using ultrashort T2* mapping.

Target Audience: Clinicians, imaging scientists, and technologists interested in emerging techniques for and applications of quantitative UTE MRI.

Outcome/Objectives: At the end of this talk, attendees should be able to:

- Describe the challenges associated with extracting quantitative data from UTE MRI techniques;
- Identify a set of emerging quantitative and semi-quantitative UTE MRI techniques that attempt to overcome these challenges;
- Identify a variety of applications to which these various emerging quantitative UTE MRI techniques are being applied.

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