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Musculoskeletal Sequences: How & Why?

Target audience:

Scientists, clinical radiologists, and technologists familiar with basic imaging techniques looking to learn from how clinical musculoskeletal MR imaging is performed.

Learning objectives:

- To explain basic technical challenges to musculoskeletal MR imaging;
- To describe how and why particular sequences are used in musculoskeletal MRI;
- To review common clinical questions for musculoskeletal MR imaging and to illustrate how particular MR pulse sequences are utilized to answer these questions.

Outline of lecture

The purpose of this lecture is not to teach MR physics, but rather to explain protocol choices with regard to musculoskeletal MRI. The main clinical questions for musculoskeletal MR imaging include post-traumatic work-up, chronic joint complaints (overuse), and arthritis.

Virtually all clinical MR protocols include proton-density weighted fast spin-echo (FSE) sequences with and without fat suppression, and T2-weighted fast spin-echo (FSE) images with fat suppression. Fluid-sensitive sequences with fat suppression are essential in every musculoskeletal MR protocol, as many pathologies demonstrate edema in bone marrow and soft tissues. Some protocols also contain T1-weighted sequences to assess bone marrow. A variety of gradient-recalled-echo (GRE) sequences have been proposed to evaluate articular cartilage, each with advantages and drawbacks. Contrast administration is usually reserved for imaging of musculoskeletal inflammation and tumors.

MR acquisition in multiple (preferable three orthogonal) planes is necessary for accurate diagnosis. Isotropic 3D sequences can be a time efficient approach to multiplanar imaging as they allow multiplanar reconstructions.

A routine clinical knee MRI protocol will be reviewed, highlighting normal anatomy and pathological conditions that can be visualized on each of the sequences and imaging planes.

The most important challenges with regard to imaging of musculoskeletal tissues will be presented. MR imaging of a variety of relevant tissues, in particular tendons, ligaments, and menisci, is hampered by short T2 relaxation time. Ultrashort echo time (UTE) sequences may overcome this issue. The magic angle artefact can occur in musculoskeletal tissues such as articular cartilage, tendon, and menisci, and can mimic relevant pathologies.

As the musculoskeletal MRI field moves towards quantitative assessment of joint tissues, a range of novel MR sequences have been introduced that are capable of measuring tissue composition, in particular that of articular cartilage. Examples are T2- and T1rho-mapping, sodium MRI, and Gag-CEST. While these are mostly used in research settings, some of these may be applied more routinely in patient care as soon as they are validated and additional value has been demonstrated.