**Specialty area:** Challenges in Musculoskeletal Imaging
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**Highlights**

- Cartilage imaging requires adequate contrast and spatial resolution.
- Normal variations in cartilage structure and signal intensity must be recognized.
- Common patterns of injury and associated in juries should direct image review.
- Accurate and precise reporting of results and ongoing QA is necessary.

**Title:** Optimizing MRI for Evaluation of Cartilage Injury
**Target audience:** – Radiologists and Orthopedic care providers
**Objectives:** – Learners will be able to optimize imaging protocols for visualization of cartilage injury and develop improved techniques for reviewing scans.
**Purpose:** – The identification of cartilage injury on MRI is often difficult but can be improved through the use of appropriate techniques and a thorough, informed review of the images.

Cartilage imaging requires sufficient contrast and spatial resolution. Ideally scans must distinguish cartilage from synovial fluid and subchondral bone, display internal fibrous structure and distinguish pathology from normal tissue. Most often these criteria are met through the use of FSE imaging which exploits differences in T2 decay with the additional benefit of magnetization transfer effects. The dynamic range of these images can be expanded through the use of fat suppression or selective water excitation.

Articular cartilage is thin, chondral injuries are frequently small and the curved irregular surfaces of joints lead to volume averaging. These challenges can be addressed through the use increased matrix size, decreased field of view and perhaps most importantly decreased slice thickness. Volumetric sequences, including 3D FSE, provide thin images capable of resolving small injuries otherwise obscured by volume averaging. Efforts to increase spatial resolution are limited by increases in imaging time and decreased signal to noise – limitations addressed by imaging with efficient coils at increased field strength. Fat suppression techniques and increasing bandwidth are particularly helpful at 3T due to the increased chemical shift. In some cases, the use of intraarticular contrast can improve both contrast and spatial resolution.

Imaging strategies should be tailored to the joint or focal abnormality being imaged. When imaging the hip, for example, MR arthrography at 3T may be useful while in most cases it simply isn't necessary when imaging the knee. Small complex joint surfaces are best displayed using volumetric imaging. Specific locations, like the femoral trochlea, may be difficult to image on routine orthogonal planes and can be examined to better effect on oblique images. This technique is especially useful when imaging focal lesions and sites of cartilage repair.

With an understanding of the normal appearance of articular cartilage and the interrelationship between variations in matrix structure, orientation to $B_0$, and T2 decay, typical variations in signal intensity can be recognized and not mistaken for pathology. In general, gradual changes in signal intensity reflect the normal variation in the orientation of matrix collagen to $B_0$. In contrast, abrupt changes in signal intensity are not typical of normal cartilage and should be considered strongly suggestive of injury or degeneration. Images should be reviewed with optimized window and level and the use of filtering should be minimized. Particular attention should be given to areas of frequent injury, areas identified by other signs of injury such as marrow signal changes and areas where cartilage is particularly difficult to evaluate. As with all imaging, accurate, standardized reporting of results is important not only for patient care but also for making possible feedback from surgical colleagues and continued improvement. You will only improve if you know what you are missing.

**References**:

Crema MD, Roemer FW, Marra MD, et al. Articular cartilage in the knee: current MR imaging techniques and applications in clinical practice and research. *RadioGraphics* 2011;31*(1)*:37–61.