77. Meniscal Tears I

Musculoskeletal MRI has long been hampered by low signal to noise ratio (SNR). The advent of high-field imaging and joint-specific surface coils, however, has obviated this problem to a large extent, establishing the modality at the forefront of musculoskeletal imaging. Striking an optimal balance between SNR and adequate spatial resolution—in particular for small structures such as the carpal tunnel and menisci—however remains difficult given the fact that increased spatial resolution results in fewer recruited hydrogen nuclei per voxel and thus lower SNR. Additional approaches such as sampling at a lower bandwidth frequency (which, depending upon how this is done, may increase image blurring) and increasing the number of scan averages can help improve SNR. Maintaining a reasonable acquisition time is a concern with the latter approach. An additional way to increase image SNR is to acquire fluid sensitive proton density-weighted images (PDWI). These images are obtained with a long TR and short or intermediate TE. Tissue contrast in PDWI is based predominately on the number of available protons. PDWI are frequently obtained with fat suppression to improve visualization of high SI abnormalities, particularly against the backdrop of fatty tissues. The choice of fat suppression technique is important in musculoskeletal MRI as areas of inhomogeneous suppression can mimic abnormalities. This can be a problem with spectral fat suppression in which a presaturation pulse is applied at the resonance frequency of fat to suppress SI. Since the resonance frequency of fat varies directly with field strength, field inhomogeneity results in some fat molecules resonating above or below the frequency of the presaturation pulse leading to non-uniform suppression. Presaturation pulse inhomogeneity has similar effects. For high field imaging—wherein separation of fat and water proton resonance frequencies is increased—with homogenous magnetic fields (i.e. adequate shimming, no ferromagnetic surgical hardware, a small field of view), spectral saturation may be preferred to STIR due to improved SNR. Inadvertent suppression of tissues with T1 values similar to fat is an additional potential drawback of STIR. As fat protons provide signal, suppression techniques, in general, reduce SNR, potentially impairing visualization of small structures. When compared to spin echo techniques, fast (turbo) spin echo techniques with fat suppression result in markedly shorter acquisition times. Acquisition times with gradient echo techniques may be even shorter; however, susceptibility artifacts and inability to produce true T2 contrast can be practical limitations. Despite this, gradient echo techniques can be helpful for the visualization of the glenoid and acetabular labra.

Knee imaging is typically obtained with a dedicated coil. While some practitioners obtain true sagittal views, sagittal views with 15 degrees of external rotation result in closer alignment with the anterior cruciate ligament and improve its visibility. However, three dimensional turbo spin echo pulse sequences with isotropic voxel size allow multiplanar reformation of such angulated planes. FS FSE PDWI are typically obtained in the axial, sagittal, and coronal planes. T1WI in at least one plane may be obtained to improve specificity for detection of marrow abnormalities. Decreasing the echo train length and sampling at higher bandwidth reduces the time available for T2 decay after a given excitation, decreasing blurring. However, modern MRI systems with improved slew rates and shorter echo spacing allow for turbo spin echo imaging with higher echo train length and less blurring.

Meniscal abnormalities are often best depicted on coronal or sagittal images. The medial meniscus is attached to the medial capsule at its periphery, while the lateral meniscus is separated from its capsule by the popliteus hiatus. The lateral meniscus is more mobile than its medial counterpart and is thus less frequently torn. Posterior horn tears of the medial meniscus are more common than tears of the anterior horn, although the lateral meniscus demonstrates no clear predilection. The normal meniscus typically consists of type 1 collagen: the slowly rotating water molecules within which drastically shorten T2—effects resulting in a low SI appearance on T1, T2, and PDWI. With increased water content, T2 relaxation is prolonged sufficiently that hyperintensity will be visualized even on short TE PDWI. A reliable MRI sign of a meniscal tear is linear fluid signal within meniscal tissues that breaches through a meniscal surface.

Figure 77.1A,B demonstrates a tear of the body and posterior horn of the medial meniscus on FS PDWI in the coronal plane. In the first image, an area of hyperintensity transversely spans the low SI medial meniscus from its inner free edge, more peripherally. The (B) second image clearly shows extension of the tear vertically to the articular surface (white arrow), a pattern suggestive of a non-displaced flap-type of tear (see Chapter 78). A more purely horizontal, cleavage-type of lateral meniscal tear does not extend to the articular surface on the coronal FS PD and T1WI of Figure 77.1C,D. This lesion is clearly delineated from the low SI meniscus on (C) FS PDWI, being much less visible on the (D) T1WI.

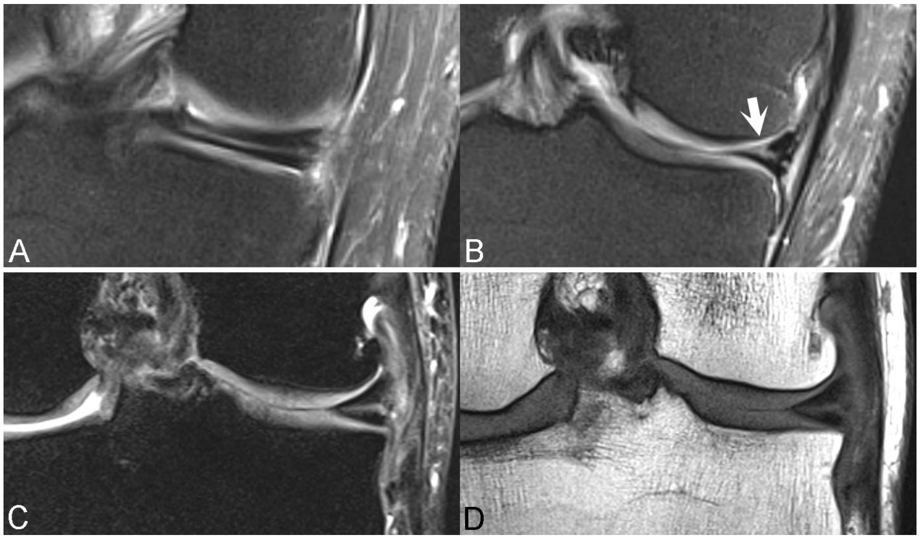

Fig. 77.1