

Dynamic MSK Imaging: Research Applications  
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Traditional MR imaging studies of the lower extremity are performed with the subject supine in a closed-bore MRI scanner. This provides excellent detail of anatomic structures in a static position, but is limited in showing the response of tissues to motion or stress. Kinematic and Real-time MRI are useful in studying the response of the musculoskeletal system to stress and during motion.

Kinematic MRI relies on the subject to perform repeatable motion cycles, akin to cardiac gating, and then an image can be reconstructed at multiple positions along the cycle. This has been used to study knee motion (1), total joint arthroplasty (2) and muscle motion (3).

Cine phase-contrast MRI can be used to determine tissue velocity during a motion cycle (4). This has also been used to measure aponeurosis tendon strain (5). Cine MRI with Displacement encoding can be used to measure muscle tissue strains near the myotendinous junction (6). Real-time MRI is useful in imaging structures while in motion, and does not require repeatable motion cycles (7, 8). As long as the frame rate of the acquisition is higher than the rate of motion, images relatively free of artifact can be produced. Frame rates can be increased by use of view sharing, spiral imaging, or parallel MR imaging. Tissue velocity can be measured with real-time MRI (9).

Open MRI scanners provide greater flexibility in performing biomechanical measurements (10, 11). Kinematic and real-time imaging in these systems is also possible, usually at lower frame rates than closed-bore systems (12). These systems can have the advantage of putting the subject in a more physiologic posture for the pain-generating activity. Combining stress and motion MR imaging with biomechanical finite-element models gives us the potential to estimate stress in joints during use (13).

## References

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