Normal MR Imaging Anatomy of the Thigh and Leg

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KEYWORDS

• Anatomy • Thigh • Leg • MR imaging • Pitfalls

Developing a solid understanding of basic magnetic resonance imaging (MR imaging) principles and musculoskeletal imaging protocols, as well as the appearance of normal imaging anatomy, is crucial to interpret musculoskeletal MR imaging examinations at a diagnostic level. This knowledge can then be applied to one's understanding of pathology commonly encountered in the area of interest. Careful attention should be focused on awareness of commonly encountered anatomic variants and diagnostic pitfalls to improve diagnostic accuracy and avoid misinterpretation.

In this article, focus is placed on depicting normal anatomy at representative levels throughout the thigh and leg, describing and providing rationale for routine imaging protocols, and discussing frequently encountered anatomical variants and imaging pitfalls. This will serve as a basic foundation for accurate evaluation of the many pathologic processes that may involve the thigh and leg.

MR imaging of a healthy volunteer was performed on a 3T MR imaging unit (Siemens, Erlangen, Germany). Select axial T1-weighted (T1W) images are displayed to depict anatomical structures to best advantage, and allow the reader to conceptualize relevant anatomy while emphasizing compartmental organization.

PROTOCOLS

Routine thigh and leg MR imaging protocols at our institution include a combination of T1W, T2W, and short tau inversion recovery (STIR) sequences. T1W sequences provide excellent depiction of anatomic detail, bone marrow signal alteration, fat within mass lesions, identification of subacute blood products, and presence of enhancing tissue after gadolinium contrast administration. T2W sequences identify tissues with increased water content that can be seen in the setting of a broad range of pathology, including neoplastic, infectious, inflammatory, and traumatic processes. Acquisition of T2W sequences is performed using the fast spin-echo (FSE) technique to reduce scan time and minimize susceptibility artifact from field inhomogeneity. Frequency selective fat suppression is used on T2W sequences to accentuate pathologic abnormalities. STIR sequences allow for a more sensitive evaluation of soft tissue and bone marrow edema, and offer more reliable uniform fat suppression; however, currently, in many institutions, FSE T2W and STIR sequences are used similarly.[1] Intravenous gadolinium contrast administration allows differentiation of cystic versus solid masses, and detection of hyperemic tissues related to viable tumor as opposed to necrosis, and phlegmonous/inflammatory tissue as opposed to abscess formation.[1] The axial plane of imaging is preferred for a compartmental approach to evaluation and in assessing the neurovascular structures, muscles, and fascial layers. The coronal plane provides a general overview of the region of interest, and the sagittal plane aids in better depicting the cranial-caudal extent of muscle disease and myotendinous junction involvement.[1,2] The field strength, coil (volume

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surface phased array), slice thickness, field of view, matrix size, and other select imaging parameters are optimized with the goal of increasing the signal-to-noise ratio and decreasing scan time, thereby decreasing motion artifact. Patient-specific factors including body habitus and ability to cooperate, desired region of coverage, and presence of metallic hardware or foreign bodies must also be considered.

Specifically, our routine protocol for both the thigh and leg (**Table 1**) includes an axial T2W sequence with fat saturation, at least 2 planes of T1W sequences without fat saturation, and coronal and sagittal STIR sequences. If gadolinium contrast is indicated, at minimum, precontrast and postcontrast fat-suppressed axial T1W sequences are obtained. At least one additional postcontrast fat-suppressed T1W sequence is acquired, either in the sagittal or coronal orientation; however, both are preferable. Ultimately, the final imaging protocol is tailored to patient-specific factors with the desired intention of obtaining the best image quality to answer the clinical question.

IMAGING ANATOMY

Thigh

The thigh is best described in terms of compartmental anatomy, and is composed of anterior, posterior, and medial (adductor) compartments. In terms of spread of pathologic processes, such as tumor and infection, other delineated compartments include the skin and subcutaneous fat, bone bounded by periosteum and cortex, and parosteal space (between the bone and overlying soft tissues).[3] The thigh extends from the superior margin of the subtrochanteric region through the distal femoral metadiaphysis. Each compartment is composed of muscles, neurovascular structures, and intermuscular fascia. Muscles are of intermediate signal intensity to fat on T1W and T2W FSE sequences.[1] Peripheral nerves are round or oval and have a fascicular appearance, best depicted on T2W sequences. They are isointense to muscle on T1W sequences with intermixed increased signal intensity similar to fat. On T2W sequences, they are isointense to slightly hyperintense relative

Table 1
Thigh (femur) and leg (tibia/fibula) routine imaging protocols: flex surface coil set up: Patient placed feet first, supine, with leg at the center of the bore of the magnet. Area of interest/concern bracketed with vitamin E capsules. 3T MR imaging unit (Siemens, Erlangen, Germany)

Thigh						
Sequence	Fat Saturation	FOV, cm	Matrix	Slice Thickness/Gap, mm	TR/TI, ms	TE, ms
Coronal T1	N	40	256 × 256	5/2.5	750	9.5
Axial T1	N	20	256 × 256	4/2.0	750	9.6
Sagittal T1	N	40	256 × 256	5/2.5	750	9.5
Axial T2	Y	20	256 × 256	4/1.2	5250	81
Coronal STIR	N/A	40	184 × 384	3/0.9	7380/210	27
Sagittal STIR	N/A	40	184 × 384	3/0.9	7380/210	27
[a]Axial T1 Pre.	Y	20	256 × 256	4/2.0	750	9.6
Leg						
Sequence	Fat Saturation	FOV, cm	Matrix	Slick Thickness/Gap, mm	TR/TI, ms	TE, ms
Coronal T1	N	35	256 × 256	5/1.5	750	9.5
Axial T1	N	20	256 × 256	5/1.5	750	9.6
Sagittal T1	N	40	256 × 256	5/2.5	750	9.5
Axial T2	Y	20	256 × 256	5/1.5	5250	81
Coronal STIR	N/A	35	184 × 384	3/0.9	7380/210	27
Sagittal STIR	N/A	40	184 × 384	3/0.9	7380/210	27
[a]Axial T1 Pre.	Y	20	256 × 256	5/1.5	750	9.6

Abbreviations: FOV, field of view; N, no; N/A, not applicable; STIR, short tau inversion recovery; Y, yes.
[a] Optional, if intravenous contrast is indicated. Post–gadolinium contrast T1W sequences are obtained in at least 2 orthogonal planes with fat suppression.