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ACR–SPR–SSR PRACTICE PARAMETER FOR THE PERFORMANCE AND INTERPRETATION OF MAGNETIC RESONANCE IMAGING (MRI) OF THE ANKLE AND HINDFOOT

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care[1]. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the practitioner in light of all the circumstances presented. Thus, an approach that differs from the guidance in this document, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in this document when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to the guidance in this document will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of this document is to assist practitioners in achieving this objective.

[1] Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, 831 N.W.2d 826 (Iowa 2013) Iowa Supreme Court refuses to find that the *ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures* (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.

I. INTRODUCTION

This practice parameter was developed and written collaboratively by the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Skeletal Radiology (SSR).

Magnetic resonance imaging (MRI) is a proven imaging modality for the detection, evaluation, staging, and follow-up of disorders of the ankle and hindfoot. Properly performed and interpreted, MRI not only contributes to diagnosis but also can guide treatment planning, help predict outcome, and increase diagnostic confidence [1-7]. However, ankle MRI should be performed only when clinically appropriate [8] and when the examination adds information not rendered from clinical examinations and radiographs. The strengths of MRI and other modalities should be weighed as to their suitability in particular patients and in particular clinical conditions.

Radiographs should be the first imaging test performed for suspected bone and soft-tissue abnormalities in the ankle and will often permit diagnosis or exclusion of an abnormality or will direct further imaging workup. Bone scintigraphy is most often used to screen the entire skeleton for multifocal diseases such as metastases, local conditions like complex regional pain syndrome, and other potentially radiographically occult bone disorders. Although MRI is typically the preferred imaging modality for suspected stress fractures and osteomyelitis of the foot and ankle, radionuclide imaging can also be useful to confirm or exclude these diagnoses [9]. Arthrography can also be used in a therapeutic role when combined with anesthetic and/or corticosteroid injection in localizing the source of pain [10-12]. Ultrasonography has come to play an increasingly important role in the diagnostic evaluation of the soft tissues of the ankle and foot, including tendons, ligaments, and soft-tissue masses [14-16].

Contrast tenography, which has been described in the evaluation and treatment of tenosynovitis in the hindfoot [17], has largely been replaced by sonography in centers in which this modality is performed. Stress radiography has been used with variable success in ankles with ligament injuries [18].

Computed tomography (CT), especially with multichannel row scanners and the use of multiplanar reformations, has an important role in the evaluation of complex fractures and dislocations of the ankle and hindfoot, osteochondral lesions, tarsal coalition, osteoid osteoma and for surgical planning [19-24]. Additionally, CT can be used for diagnosis of bone and soft-tissue injuries when there is a contraindication to MRI [25,26]. 3-D volume rendering can show the anatomic relationships of bones and tendons, which may be useful for preoperative planning [27,28]. When combined with arthrography, CT can also be used for evaluating the articular cartilage and joint bodies [29].

Although MRI is a sensitive, noninvasive diagnostic test for detecting anatomic abnormalities of the ankle and hindfoot, its findings may be misleading if not closely correlated with radiographs, clinical history, physical examination, physiologic tests such as nerve conduction analysis and electromyography, and other imaging studies when indicated. Adherence to the following parameters will increase the probability of detecting clinically important abnormalities.

II. INDICATIONS

A. Primary indications for MRI of the ankle and hindfoot include, but are not limited to, diagnosis, exclusion, and grading of the following suspected disorders:

1. Achilles tendon disorders: partial and complete tears, tendinitis, tendinopathy, treated tears, paratenonitis, and xanthomas[2] [5,30-34]
2. Posterior tibial tendon disorders: partial and complete tears, tendinitis, tendinopathy, tenosynovitis, subluxation, and dislocation [3,35-40]
3. Peroneal tendon disorders: partial and complete tears, tendinitis, tendinopathy, tenosynovitis, subluxation, dislocation, and abnormalities of the peroneal retinaculum [14,41-44]
4. Abnormalities of other hindfoot tendons: partial and complete tears, tendinitis, tendinopathy, tenosynovitis, and entrapment [11,45-49]

[2] Conditions in which intravenous (IV) contrast may be useful

5. Anterior and posterior talofibular, anterior and posterior tibiofibular, calcaneofibular, deltoid, spring, and syndesmotic ligament tears[3] [6,13,18,50-58]
6. Impingement syndromes: anterolateral, anteromedial, posterior, and posteromedial[2,3] [13,40,59-67]
7. Osteochondral abnormalities, degenerative or traumatic articular cartilage abnormalities, and intra-articular bodies[3] [13,29,68-74]
8. Neurologic conditions: nerve entrapment and compression, denervation neuropathy, including tarsal tunnel syndrome[2] [75-80]
9. Plantar fasciitis, plantar fascia rupture, and plantar fibromatosis [81-84]
10. Sinus tarsi syndrome[2] [85]
11. Synovial-based disorders: inflammatory and nodular synovitis, tenosynovitis, bursitis, and ganglion cysts[2] [46,86-89]
12. Marrow abnormalities: fractures, bone contusions, osteonecrosis, marrow edema syndromes, and stress fractures[2] [90-94]
13. Neoplasms of bone, joint, or soft tissue[2] [95-99]
14. Infections of bone, joint, or soft tissue[2] [100-103]
15. Congenital and developmental conditions: alignment anomalies and dysplasia, tarsal coalition, and symptomatic and asymptomatic normal variants such as accessory ossicles [76,104-109]

B. MRI of the ankle and hindfoot may be indicated to further clarify and stage conditions diagnosed clinically and/or suggested by other imaging modalities, including, but not limited to:

1. Arthritides: inflammatory, infectious, neuropathic, degenerative, crystal-induced, and posttraumatic[2] [4,36,46,87,110-114]
2. Primary and secondary bone and soft-tissue tumors[2] [95-98,115] (see also the ACR–SPR–SSR Practice Parameter for the Performance and Interpretation of Magnetic Resonance Imaging (MRI) of Bone and Soft-Tissue Tumors [116])
3. Fractures and stress fractures [117-119]

C. MRI of the ankle and hindfoot may be useful to evaluate specific clinical scenarios, including, but not limited to:

1. Prolonged, refractory, or unexplained ankle or heel pain[2,3]
2. Acute ankle trauma [7,55,120,121]
3. Ankle and hindfoot injuries in athletes[3] [90,122-125]
4. Ankle or subtalar instability[3] [6,51,55,126,127]
5. Ankle and/or hindfoot malalignments [40,108]
6. Limited or painful range of motion
7. Unexplained ankle or hindfoot swelling, mass, or atrophy[2]
8. Patients for whom diagnostic or therapeutic arthroscopy is planned[3]
9. Patients with recurrent, residual, or new symptoms following ankle surgery[3] [34,126,128-131]
10. Patients or relatives with familial hypercholesterolemia or hyperlipidemia [31,132,133]

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Parameter for Performing and Interpreting Magnetic Resonance Imaging (MRI) [134].

IV. SAFETY GUIDELINES AND POSSIBLE CONTRAINDICATIONS

See the ACR Practice Parameter for Performing and Interpreting Magnetic Resonance Imaging (MRI) [134] and the ACR Guidance Document on MR Safe Practices 2020 [135].

Peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis [136,137].

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[3] Conditions in which intra-articular contrast (performed by direct intra-articular injection or indirect joint opacification following IV administration) may be useful

V. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for MRI of the ankle and hindfoot should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state's scope of practice requirements. (ACR Resolution 35 adopted in 2006 – revised in 2016, Resolution 12-b)

The supervising physician must have adequate understanding of the indications, risks, and benefits of the imaging examination as well as alternative imaging procedures. The physician must be familiar with potential hazards associated with MRI, including potential adverse reactions to contrast media (see the ACR Manual on Contrast Media [138]). The physician should be familiar with relevant ancillary studies that the patient may have undergone. The physician performing MRI interpretation must have a clear understanding and knowledge of the anatomy and pathophysiology relevant to the MRI examination.

The supervising physician must also understand the pulse sequences to be used and their effect on the appearance of the images, including the potential generation of image artifacts. Standard imaging protocols may be established and varied on a case-by-case basis when necessary. These protocols should be reviewed and updated periodically.

A. Patient Selection

The physician responsible for the examination should supervise patient selection and preparation and be available in person or by telephone for consultation. Patients must be screened and interviewed prior to the examination to exclude those who may be at risk by exposure to the MR environment.

Certain indications require administration of intravenous (IV) contrast media. IV contrast enhancement should be performed using appropriate injection protocols and in accordance with the institution's policy on IV contrast utilization (see the ACR–SPR Practice Parameter for the Use of Intravascular Contrast Media [139]).

Pediatric patients or patients suffering from anxiety or claustrophobia may require sedation or additional assistance. Administration of moderate sedation or general anesthesia may be needed to achieve a successful examination, particularly in young children. If moderate sedation is necessary, refer to the ACR–SIR Practice Parameter for Minimal and/or Moderate Sedation/Analgesia [140].

B. Facility Requirements

Appropriate emergency equipment and medications must be immediately available to treat adverse reactions associated with administered medications. The equipment and medications should be monitored for inventory and drug expiration dates on a regular basis. The equipment, medications, and other emergency support must also be appropriate for the range of ages and sizes in the patient population.

C. Examination Technique

Diagnostic-quality ankle and hindfoot MRI is possible using a variety of magnet designs (closed or open) and field strengths [112]. Utilizing a 3T scanner can provide multiple advantages over 1T or 1.5T. The higher field strength results in a near linear increase in signal-to-noise ratio (SNR), which can be used to improve resolution, decrease acquisition time, or both. However, this comes at the cost of increased metallic susceptibility with resulting greater signal loss, geometric distortion, and heterogeneous fat suppression as well as more pronounced chemical shift and pulsation artifacts [141,142]. Additionally, at least in cadaveric ankle studies, images obtained with a 3T scanner may have higher accuracy for articular cartilage abnormalities in the ankle compared with those obtained with 1T or 1.5T scanners [143,144]. When imaging the ankle and hindfoot on low-field scanners, the reduced SNR necessitates modifications in the imaging parameters [146]. For example, the number of signals averaged can be increased at the expense of longer imaging times and increased risk of involuntary patient motion [147]. Alternatively, the voxel size can be increased (by a combination of larger field of view [FOV], thicker slices, and/or decreased matrix) at the expense of spatial resolution. In addition, fat-suppression techniques that rely on the difference between fat and water precessional frequencies (chemical shift) are unreliable at low field strength and substituting short-tau inversion recovery (STIR) images may be necessary.

MR scanners that are built for extremity-only imaging can also be used for the hindfoot and ankle [120,148]. Low-field–dedicated extremity machines are more susceptible to artifacts and degraded image quality than their high-field counterparts [148,149]. Conversely, newer high-field–dedicated scanners impose a limitation on the useable FOV, which may make imaging a long structure like the entire Achilles tendon problematic.

Regardless of system design, a local receiver coil is mandatory to maximize the SNR [150]. Several choices are available for the ankle and hindfoot [151]. Although not widely available, a local gradient coil can be used to generate images with extremely high resolution to depict the fine detail of anatomic structures like the ankle collateral ligaments [145]. A whole-volume extremity coil allows examination of the ankle in neutral position or plantar flexion, with the patient lying supine or possibly prone, if the hardware allows. A pair of surface coils joined in an array or in a Helmholtz configuration can substitute for a whole-volume coil, if one is not available. If both ankles are to be imaged, examining each side separately with a smaller coil (eg, an extremity coil) will provide better SNR and higher-resolution imaging [152] than can be achieved by imaging both ankles together in a larger coil (eg, a head coil). A single surface coil can image superficial structures, but for high-resolution imaging of very small, relatively superficial structures, a microscopy coil will provide the SNR necessary at the expense of anatomic coverage [96]. Newer multichannel coils containing multiple coil elements will further increase SNR and are required in use of techniques like parallel imaging that decrease the time of the scan. The coil selected for a given study will also influence limb positioning.

Patient and hindfoot positioning may be individually tailored to the specific indication(s). Allowing the patient to plantar flex the ankle avoids aliasing of the toes onto the heel when the phase direction is oriented along the long axis of the foot [151]. Plantar flexion, which is possible with the patient either supine or prone, also reorients the medial and lateral ankle tendons so that a single imaging plane can show a larger length of each in cross section and so that a smaller segment of each tendon will pass through the magic angle [153,154]. However, this nonstandard position may make visualization of the ankle ligaments more difficult [54,155] and may make it harder to include the entire Achilles tendon in the FOV. The prone position is more comfortable for some patients, reduces involuntary motion, and may reduce claustrophobic feelings in susceptible individuals [156].

Ankle and hindfoot MRI usually includes images acquired in both the short axis and long axis of the foot. These may be sagittal, coronal, transverse, or oblique to the bore of the magnet and to the limb, depending on the position of the ankle. It is beneficial to orient the imaging planes orthogonal to a specific anatomic structure: for the ankle, the talar dome is commonly used; for the hindfoot, the posterior subtalar joint is used [37]. Multiplanar images can be acquired directly or reconstructed electronically from volumetric data acquired in one imaging plane. Standard MR software also allows the prescription of oblique images in virtually any plane if images oriented along the course of a given structure are needed [157]. Oblique sagittal, axial, and coronal sequences have been utilized for improved assessment of the peroneal tendons, syndesmotic ligaments, and calcaneofibular ligaments, respectively, although are not required [141].

The size of the anatomic structures under consideration and the suspected pathology determine the necessary FOV. For example, visualization of the entire extent of a large Achilles tendon tear may require a 22-cm FOV in the sagittal plane, although a FOV of 12 cm or smaller in the coronal plane may be needed to demonstrate small chondral defects around the ankle joint, the syndesmotic ligaments, and the contents of the sinus tarsi [55,143,144]. For routine ankle and hindfoot studies, a FOV of 16 cm or less is desirable for detecting most clinically relevant disorders. A rectangular FOV for coronal and transaxial images of the hindfoot can save imaging time without sacrificing in-plane resolution [151]. Slice thickness should be 4 mm or less to minimize partial-volume effects, but thinner sections may be advantageous for detailed analysis of the ligaments and articular cartilage. Typically, an interslice gap no wider than 10% of the slice width will ensure complete visualization of the intra-articular structures. However, when relatively larger abnormalities like tumors or infections are being imaged, an interslice gap of up to 33% may be useful to increase anatomic coverage and/or decrease imaging time in studies in which motion artifacts are unavoidable. Acquiring 3-D gradient-recalled images as a volume and reconstructing them into 1-mm or thinner slices can assist in the visualization of normal and abnormal ligaments and intratendinous disorders [158], although multiplanar reconstructions of the ankle ligaments can also be produced from conventional 2-D sequences [159]. 3-D imaging is currently used in many centers using turbo spin-echo (TSE)–type sequence (SPACE, VISTA, etc), which allows sub-1-mm scanning. The imaging matrix should balance SNR with desired in-plane spatial resolution and reduction of truncation artifacts, but should be at least 192 steps in the phase-encoding direction and 256 steps in the frequency-encoding direction for 2-D imaging. Even higher matrices combined with smaller FOVs can show fine intratendinous detail [30,160].

A wide variety of pulse sequences—conventional spin-echo, fast (turbo) spin-echo, and gradient-recalled echo—are available for ankle and hindfoot MRI [151]. The choice of sequences may be optimized to address specific clinical questions, and many practices tailor protocols based on the suspected pathology. A typical imaging protocol will be composed of 1 or more pulse sequence types. The exact repetition time (TR), echo time (TE), and flip angle chosen will depend on the field strength of the magnet and the desired relative contrast weighting.

Fluid-sensitive (T2-weighted or STIR) sequences are typically used for evaluating the ankle and hindfoot ligaments [54]. These sequences complement short-TE (T1-weighted or proton-density–weighted) sequences for plantar fascia and tendon imaging [37,41,81,153] and are especially important to compensate for magic angle artifact seen in tendons [158]. Fat-suppressed T2-weighted or STIR images are most sensitive for bone marrow abnormalities [92,94,106], although T1-weighted images are still important for marrow lesion characterization. T1-weighted sequences also have a role in the detection of various stages of hemorrhage and muscle disorders [161], as well as tendon infiltration [132,133]. Evaluation of articular cartilage and osteochondral infractions can be performed with fast spin-echo, long-TR (water-sensitive or intermediate-weighted) images or with gradient-echo sequences [143,162,163]. Gradient-echo sequences can also demonstrate tendon infiltration by xanthomas and fractures involving the open growth plates [117]. In addition, they can also be used when there is suspicion of tenosynovial giant-cell tumor or hemophilia in which the presence of paramagnetic hemosiderin results in amplified signal dropout ("blooming" artifact), a characteristic feature [164]. Effusions, cysts, and intra-articular impingement lesions are most conspicuous on T2-weighted sequences [89,165], although T1-weighted images, especially when using fat suppression, following gadolinium-based IV contrast administration may be useful to characterize synovial processes [87,166].

IV contrast enhancement may be useful for evaluating ankle and hindfoot tumors and infections [98,100,101] and may have an adjunct role for tendon imaging [32] and for intrasynovial disorders [60]. Additionally, gadolinium-enhanced MR arthrography, by either direct intra-articular injection or indirect diffusion into the joint following IV injection, may improve diagnostic performance for detecting chronic ligament abnormalities, osteochondral and articular cartilage defects, and impingement lesions [13,29,51,71,95]. Spin-echo, fast spin-echo, or gradient-recalled T1-weighted images with fat suppression are used for contrast-enhanced MR sequences [52,60] At least 1 fluid-sensitive sequence is still necessary when performing MR arthrography to detect extra-articular pathology, as well as at least 1 T1-weighted sequence without fat suppression for evaluating bone marrow and characterizing soft-tissue lesions.

Suppressing the signal from fat may enhance the diagnostic yield of some pulse sequences [152]. Fat suppression is most frequently performed using spectrally selective radiofrequency (RF) pulses; however, this technique is limited by field heterogeneity. Dixon techniques are widely available and provide superior fat signal suppression in the setting of field heterogeneity accentuated by the off-center position and irregular air–soft-tissue interfaces often encountered when imaging the ankle and foot [167]. Other methods that are less reliant on field heterogeneity include pulse sequences that decompose fat and water iteratively or null signal from short T1 tissues, such as fat using an inversion pulse (STIR) [168-172]. The STIR technique may be necessary on low-field systems but will also null gadolinium on gadolinium contrast acquisitions. Techniques that rely on separate acquisitions to obtain separate fat and water images are prone to misregistration artifacts because of motion, but combining these sequences with a motion-correction algorithm can result in robust fat suppression in reasonable scan times [173]. Fat suppression is a useful adjunct to T1-weighted images when IV contrast is used or when MR arthrography is performed with a dilute gadolinium mixture [65,174].

It may be possible to shorten the time required for an ankle or hindfoot MR examination without compromising diagnostic yield. Parallel imaging techniques decrease acquisition times for individual pulse sequences, but at the expense of decreased SNR and the required use of a multichannel receiver coil [175,176]. Alternatively, newer fast 3-D gradient-recalled and fast spin-echo sequences can produce near-isotropic images that can be reconstructed into multiple imaging planes; using these methods, a single volumetric acquisition can substitute for several acquisitions in separate imaging planes, thereby decreasing the total time required for a complete examination [60,174].

Various techniques are useful to minimize artifacts that can degrade image quality. Aliasing is reduced or eliminated by repositioning the extremity (eg, plantar flexing the hindfoot to prevent images of the toes from superimposing on the heel), by orienting the phase-encoding direction anterior-to-posterior when possible, by shielding body parts outside of the area of interest, or by the use of phase oversampling [151,177,178]. Gentle immobilization combined with patient comfort measures best controls involuntary motion [152], although newer pulse sequences can partly correct for some limb motion [173]. Presaturation pulses or gradient moment nulling will reduce ghosting artifacts from flowing blood and other periodic motion [177,179]. Chemical shift artifact is most severe at high field strengths and may necessitate an increase in the receiver bandwidth on high-field scanners [147,177]. Susceptibility artifacts, which originate from heterogeneity of the local field, are also more severe at higher field strengths, in the presence of metallic implants, and when using gradient-recalled pulse sequences. Avoiding gradient-echo imaging and reducing the voxel size by increasing the imaging matrix and/or decreasing the slice thickness and FOV will help reduce the magnitude of susceptibility artifacts [177]. Lastly, magic angle artifact can produce apparently increased signal intensity on short TE images within tendons that curve around the ankle, mimicking intratendinous pathology [180-182]. Plantar flexing the hindfoot to reorient the tendons can reduce this phenomenon [154]. Confirming abnormal signal intensity in the tendons on images with a longer TE and correlating apparent signal intensity abnormalities with changes in tendon thickness will also help avoid this pitfall [151,153].

It is the responsibility of the supervising physician to determine whether additional or unconventional pulse sequences and imaging techniques confer added benefit for the diagnosis and management of the patient. Examinations that use techniques not approved by the Food and Drug Administration, such as the intra-articular injection of gadolinium chelates (direct MR arthrography) [183], can be considered when they are judged to be medically appropriate.

VI. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Parameter for Communication of Diagnostic Imaging Findings [184].

At a minimum, the report should address the condition of the major ankle tendons, ligaments, and joints. In selected cases, a description of findings in the bone and bone marrow, synovium, joints, retinacula, muscles, sinus tarsi, plantar fascia, neurovascular structures, and subcutaneous tissue would be appropriate. The report should use standard anatomic nomenclature and precise terms for describing identified abnormalities whenever possible.

Specific policies and procedures related to MRI safety should be in place along with documentation that is updated annually and compiled under the supervision and direction of the supervising MRI physician. Guidelines should be provided that deal with potential hazards associated with the MRI examination of the patient as well as to others in the immediate area [136,137,185]. Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination [186].

VII. EQUIPMENT SPECIFICATIONS

Equipment monitoring should be in accordance with the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance (MR) Imaging Equipment [187].

The MRI equipment specifications and performance must meet all state and federal requirements. The requirements include, but are not limited to, specifications of maximum static magnetic strength, maximum rate of change of the magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels.

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *ACR Position Statement on Quality Control & Improvement, Safety, Infection Control, and Patient Education* on the ACR website (https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Quality-Control-and-Improvement).

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