Revised 2017 (Resolution 6)*

ACR–SCBT-MR–SPR–SSR PRACTICE PARAMETER FOR THE PERFORMANCE OF MAGNETIC RESONANCE IMAGING (MRI) OF THE WRIST

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.

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[1] Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, ___ N.W.2d ___ (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 revised and written collaboratively by the American College of Radiology (ACR), the Society of Computed Body Tomography and Magnetic Resonance (SCBT-MR), the Society for Pediatric Radiology (SPR), and the Society of Skeletal Radiology (SSR).

Magnetic resonance imaging (MRI) is a proven, established imaging modality for the detection, evaluation, staging, and follow up of disorders of the wrist. Properly performed and interpreted, MRI not only contributes to diagnosis but also serves as an important guide to treatment planning and prognosis [1-19]. Early use of wrist MRI for patients with suspected scaphoid fractures has been found to decrease the morbidity that can be associated with these types of injuries, including cost, time immobilized, and time away from work [20-23]. However, it should be performed only for a valid medical reason and only after careful consideration of alternative imaging modalities [24]. The strengths of MRI and other modalities should be weighed against their suitability in particular patients and in particular clinical conditions.

A 3-view or 4-view radiographic examination should be the first imaging test performed for suspected bone, joint, and soft tissue abnormalities in the wrist. It will often suffice for diagnosis or exclusion of an abnormality or will direct further imaging workup [25]. Bone scintigraphy may be used to evaluate for radiographically occult scaphoid and other fractures [26-28] but may have lower specificity than MRI or computed tomography (CT) [29]. Fluoroscopic examination can be used for evaluating carpal instability, and 1- to 3-compartment arthrography can be used for diagnosing and staging abnormalities of the triangular fibrocartilage complex (TFCC) and wrist ligaments [30,31]. High-resolution sonography may be considered as an acceptable alternative to MRI in the evaluation of suspected ganglion cysts [32], synovitis [33], and bone erosion [15]. Sonography may also be considered in the evaluation of scaphoid fractures [34-36], disorders of the TFCC and scapholunate ligament, and carpal tunnel syndrome [37-41].

CT with multi-detector row scanners and multiplanar reformatted images plays an important role in the characterization of chip fractures, malalignments, and other osseous abnormalities and in the post-treatment evaluation of fractures of the scaphoid and the distal radius and their complications [42-44]. Multi-detector CT wrist arthrography with multiplanar reformatted images can show defects of the intrinsic ligaments, the TFCC, and articular cartilage [45,46]. Last, arthroscopy provides a detailed but invasive examination of the intra-articular structures of the wrist, allowing the surgeon to diagnose and treat many internal derangements [47-49].

Although MRI is often the most sensitive noninvasive diagnostic test for detecting anatomic abnormalities of the wrist, MRI findings may be misleading if not correlated with clinical history, physical examination, laboratory tests, physiologic tests such as nerve conduction analysis and electromyography, and other imaging studies [50,51]. Adherence to the following practice parameters should enhance the probability of detecting clinically important abnormalities.

II. INDICATIONS

A. Primary indications for MRI of the wrist include, but are not limited to, diagnosis, exclusion, grading, and/or treatment planning of suspected:
   1. Abnormalities of the triangular fibrocartilage complex: partial tears, complete tears, and degeneration [47,52-61]†
   2. Abnormalities of the scapholunate and lunotriquetral interosseous ligaments: sprains, partial tears, and complete tears [45,53,56,57,59,60,62,63]†
   3. Abnormalities of the dorsal and volar extrinsic wrist ligaments [54,56,59,64]†*
   4. Ulnocarpal impaction syndrome [5,65-68]†
   5. Fractures of the distal radius, scaphoid, and other carpal bones with normal or equivocal radiographs [4,29,69-78]
   6. Soft tissue injuries associated with distal radius fractures [79]

7. Complications of scaphoid fractures: displacement, nonunion, malunion, and osteonecrosis [80-85]*
8. Osteonecrosis of the carpal bones [80-82,85-89]*
9. Ganglion cysts [32,90]*
10. Carpal tunnel syndrome: primary, secondary, and recurrent [91-101]
11. Abnormalities of peripheral nerves: Guyon canal syndrome [102,103], entrapment [104-106], hamartomas [107], and tumors [107-111]*
12. Flexor and extensor tendon disorders: partial and complete tears, tendinopathy, and tenosynovitis [112-117]*
13. Osteochondral and articular cartilage lesion: [60,118-120]†
14. Vascular abnormalities: arterial aneurysms and pseudoaneurysms, varices, hemangiomas, and vascular malformations [121,122]*
15. Congenital and developmental conditions: dysplasia and clarification of normal variants [102,113,123-126]

B. MRI of the wrist may be indicated to further clarify, stage, and follow up conditions diagnosed clinically and/or suggested by other imaging modalities, including, but not limited to:
   1. Neoplasms of bone, joint, tendon sheath, or soft tissue [112,127-132]* See also the ACR–SSR Practice Parameter for the Performance and Interpretation of Magnetic Resonance Imaging (MRI) of Bone and Soft Tissue Tumors [133].
   2. Infections of bone, joint, or soft tissue [122,134-137]* See also the ACR–SPR–SSR Practice Parameter for the Performance and Interpretation of Magnetic Resonance Imaging (MRI) of Bone, Joint, and Soft Tissue Infections in the Extremities [138]
   3. Rheumatoid arthritis, juvenile idiopathic arthritis, psoriatic arthritis, gout, and related diseases [6-12,14,139-155]*

C. MRI of the wrist may be useful to evaluate specific clinical problems, including, but not limited to:
   1. Acute and chronic wrist instability [60,76][2]†
   2. Dorsal or ulnar-sided wrist pain [5,60,65,90][2]†
   3. Wrist symptoms in adolescent gymnasts and other athletes [156-159]
   4. Unexplained chronic wrist pain [57,60,160,161][2]†
   5. Acute wrist trauma [2,3,74]
   6. Wrist malalignments[2]†
   7. Limited or painful range of motion[2]†
   8. Unexplained wrist swelling, mass, or atrophy [130,162,163][3]*
   9. Planning for diagnostic or therapeutic arthroscopy[2]†
   10. Recurrent, residual, or new symptoms following wrist surgery [80][2,3]*†

III. SAFETY GUIDELINES AND POSSIBLE CONTRAINDICATIONS

See the ACR Practice Parameter for Performing and Interpreting Magnetic Resonance Imaging (MRI) [164], the ACR Manual on Contrast Media [165], and the ACR Guidance Document on MR Safe Practices [166].

Peer-reviewed literature pertaining to MR safety should be reviewed on a regular basis [167,168].

IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Parameter for Performing and Interpreting Magnetic Resonance Imaging (MRI) [164].

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

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

V. SPECIFICATIONS OF THE EXAMINATION

The supervising physician must have complete understanding of the indications, risks, and benefits of the 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. 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 written or electronic request for MRI of the wrist 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)

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 phone 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 [169].)

Pediatric patients or patients suffering from anxiety or claustrophobia may require sedation or additional assistance. Administration of moderate sedation or occasionally 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 Sedation/Analgesia [170].

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

High-resolution wrist MRI is typically done using high field strength (≥1.0 T) systems [55,58,59,171]. However, applications that rely on contrast resolution rather than high spatial resolution – such as evaluation for occult fractures, carpal bone osteonecrosis, or diffuse wrist synovitis – may be accomplished with lower field strength (0.1 to 0.9 T) units [70,71,86,87,142,172]. In these situations, the reduced signal-to-noise ratio (SNR) inherent at lower field strength may necessitate modifications in the imaging parameters [173]. For example, increasing the number of signals averaged improves SNR at the expense of longer imaging times and risk of involuntary patient motion [174]. Alternatively, an increase in voxel size (by a combination of larger field of view (FOV), thicker slices, and/or decreased matrix) will increase SNR, but at the expense of spatial resolution [142]. Fat suppression techniques that rely on the difference between fat and water precessional frequencies (chemical shift) may be unreliable at low field strength, and substituting short-TI inversion recovery (STIR) images may be necessary [175]. Overall, a balance of high spatial resolution, high SNR, and high contrast resolution is important to optimize wrist MRI for the evaluation of bone and soft tissue injuries [176].

A local receiver coil is mandatory to maximize the SNR [177]. Many choices are available for wrist MRI. Curved or flat surface coils can be used alone or paired in a Helmholtz configuration [53,55,57,60]. "Microscopy" surface coils <5 cm in diameter can provide exquisitely detailed images of individual structures like the TFCC, but with a limited FOV that does not allow imaging of the entire wrist [178,179]. Whole-volume, send-receive, and receive-only coils for wrist imaging have been designed in saddle, birdcage, solenoid, quadrature, and phased-array configurations [53-56,160,180,181]. Larger coils such as those used for extremity (knee) imaging will typically have lower SNR but may be useful when a larger aperture is required. Examples include imaging both wrists simultaneously in a patient with rheumatoid arthritis or suspected distal radioulnar joint (DRUJ) subluxation or examining a fractured wrist in a splint or cast [60,79,182]. In using a larger coil for unilateral wrist MRI, a small extremity setting should be selected if it is available.

The choice of coils often dictates positioning of the patient and extremity. Most whole-volume coils (those designed to completely surround a limb) can be positioned next to the patient, who then lies supine with the affected arm at the side [52,54,55,183]. Although this position is comfortable, allowing the patient to remain motionless, the magnetic field homogeneity at the periphery of the magnet is less than at the center and may result in lower SNR or difficulty achieving homogeneous, chemically selective fat saturation. Patients can be rolled partly onto their sides to place the wrist more centrally. Other coil designs can be centered in the bore of the magnet, which requires the patient to lie prone, semiprone, or supine with the affected wrist overhead [73,171]. However, some patients may not tolerate the overhead position as it may produce upper extremity pain, although some claustrophobic patients are more relaxed lying face down [184]. Solenoid coils need to be positioned perpendicular to the main magnetic field. Typically in a high field, whole-body scanner the patient would lie prone with the arm abducted above the head and the elbow minimally flexed when using a wrist solenoid coil [54]. Magic angle artifacts will occur if the wrist is angled significantly in the magnet. When evaluating for radioulnar instability it may be appropriate to image the patient with the wrist in full supination and then in full pronation in the axial plane [185]. Imaging with the wrist in ulnar and/or radial deviation may be beneficial for evaluating intrinsic ligaments [186].

Wrist MRI typically includes images acquired in 3 orthogonal planes. The coronal plane depicts the wrist ligaments, TFCC, bones, and the radiocarpal, intercarpal, and carpometacarpal joints [187]. Transverse images are used to evaluate the carpal tunnel and Guyon's canal, the flexor and extensor tendons and tendon sheaths, the intrinsic wrist ligaments, the neurovascular structures, the distal radioulnar joint, and suspected masses [32,92,187]. Sagittal images contribute to the assessment of masses, including ganglia; the tendons; and the articulations and alignment of the bones [32,187]. Fracture assessment often requires evaluation of the sagittal and coronal images together [69,73,81]. Oblique planes may be useful to evaluate the thin extrinsic ligaments or intrinsic intercarpal ligaments and can be obtained as either a primary 2-D MRI sequence or a reformation of a 3-D sequence [188-190]. 3-D fast spin echo sequences now available on many platforms can be acquired as a single volume and used to generate thin-section intermediate or long echo time (TE) images in multiple planes to supplement or replace separate acquisitions in individual planes [191]. 3-D sequences with MR arthrography have been reported to better demonstrate ligament and TFCC injuries than standard 2-D MRI [192].

Although a FOV of 16 cm may provide adequate spatial resolution for detecting fractures [71,73], a FOV of 6 to 12 cm is typically preferred to consistently visualize the TFCC and wrist ligaments [53,56,57,62,188,189,193]. When the coil and scanner can provide adequate SNR, a 6 to 8 cm FOV is ideal for visualization of the individual portions of these structures and accurate diagnosis of abnormalities [54,55,58,60,181,183,194]. Using a rectangular FOV can save imaging time without sacrificing in-plane resolution. For 2-D pulse sequences, slice thickness should be 3 mm or less to minimize partial-volume effects [54,57,59,60,70,71]. Imaging at greater than 1.5 T field strengths may allow a larger FOV to be used with adequate detail, produce images with higher detail at a smaller FOV, as is often necessary for pediatric patients, or produce images of conventional FOV and detail but with a shorter scan time [63,195].

An interslice gap of no more than 33% of the slice width can increase coverage and decrease signal loss due to interslice cross-talk [196] but should not impair complete visualization of the intra-articular structures. 3-D pulse sequences are frequently used in wrist MRI to provide thin, contiguous sections that depict the components of the ligaments and TFCC; the imaging volume is typically partitioned into 0.6 to 1.2 mm sections [53,55,56,58,62,181,183,188,194,197]. The imaging matrix should balance intravoxel SNR with desired in-plane spatial resolution and reduction of truncation artifacts but should be at least 192 steps in the phase direction and 256 steps in the frequency direction for 2-D imaging [54,55,58,181,183]. In certain situations it may be appropriate to use a reduced imaging matrix such as 256 × 160 to improve temporal resolution and reduce motion artifacts, such as for multiphase, intravenous contrast-enhanced imaging or for kinematic imaging of joint motion. Use of higher imaging matrices will decrease voxel size and increase spatial resolution, but at the expense of imaging time or lower SNR [59].

A wide variety of pulse sequences — conventional spin-echo, fast (turbo) spin-echo (FSE), STIR, and gradient-recalled echo — are available for wrist MRI. The choice of sequences may be optimized to address specific clinical questions and may vary according to local preferences. A typical imaging protocol will be composed of 1 or more of these pulse sequence types. The 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.

For non-arthrographic studies, fluid-sensitive (T2-weighted, T2*-weighted [gradient echo], fat-suppressed intermediate-weighted [long-TR, TE 30 to 60 ms], or STIR), or proton density-weighted (long-TR, short-TE) sequences are used for evaluating the wrist ligaments, TFCC, and articular cartilage [6,54,55,57-60,183,194]. Evaluation of joint effusions, synovitis, tenosynovitis, ganglion cysts, and tendons also relies on fluid-sensitive sequences [32,90]. Fat-suppressed T2-weighted or STIR images are most sensitive for detecting bone marrow edema and edema-like changes [66,68,70], although T1-weighted images are important for characterizing marrow lesions such as fractures and osteonecrosis [69,71,74,79,198]. With gradient-recalled echo based pulse sequences, lower flip angles will generate T2*-weighted images, although larger flip angles and radiofrequency (RF) spoiling make the images relatively more T1-weighted [53,59]. Fat-suppressed 3-D spoiled gradient-recalled echo imaging is useful for the evaluation of any growth disturbance or associated abnormality that may follow physeal injury [199]. T1-weighted images, especially using fat suppression, following intravenous gadolinium-based contrast administration are useful for characterizing synovial processes and vascularity of tumors and other lesions. [80-82,139,140,142,144].

Gadolinium-enhanced MR arthrography may improve diagnostic performance for TFCC, ligament, and articular cartilage abnormalities in the wrist [53,56,57,59,118,200-202]. A dilute contrast mixture can be injected directly into the radiocarpal joint (direct MR arthrography) [57,59]. Alternatively, the radiocarpal, midcarpal, and distal radioulnar joints can all be enhanced directly by 3-compartment injection [56,62]. If direct MR arthrography is unavailable, joint enhancement can be accomplished indirectly by intravenous contrast injection followed by a short delay or wrist exercise (indirect MR arthrography) [53,203]. Spin-echo or gradient-recalled echo T1-weighted images with fat suppression are used for MR arthrography [53,56,59,62,203]. At least 1 fluid sensitive sequence is still necessary when performing MR arthrography to detect abnormalities that do not communicate with the joint, as well as at least 1 T1-weighted sequence without fat suppression for evaluating bone marrow and characterizing soft-tissue lesions. Direct MR arthrography is an invasive procedure and should be performed after consideration of anticipated benefits and risks [204]. The addition of traction techniques to wrist MR arthrography has been reported to enhance the detection of ligament, TFCC, and cartilage injuries [205,206], but these techniques are not routinely used in most practices.

Intravenous gadolinium chelate contrast-enhanced MRI (CE-MRI) with T1-weighted pulse sequences can be used for specific conditions of the wrist, in addition to indirect MR arthrography and contrast-enhanced MR angiography. CE-MRI has a role for tumor characterization, and MR angiography has a role for evaluating vascular anomalies (see the ACR-SSR Practice Parameter for the Performance and Interpretation of Magnetic Resonance Imaging (MRI) of Bone and Soft Tissue Tumors [133]). CE-MRI has been shown to be effective in assessing the viability of scaphoid fragments in nonunion with time-resolved post-contrast images obtained to assess arterial enhancement and standard delayed enhancement [89,207-215]. CE-MRI can help differentiate rheumatoid from psoriatic arthritis [145,148,151,154] and may predict progression of unclassified arthritis to rheumatoid arthritis [147]. CE-MRI has been used as a surrogate marker for synovitis in rheumatoid arthritis, providing a more accurate assessment of disease activity than non-contrast-enhanced MRI [9,152,216,217] as well as a marker for treatment monitoring [10,155,218,219]. CE-MRI adds sensitivity for detecting tenosynovitis in inflammatory arthritis patients, which can be an early marker of disease [114,117]. Differentiation of a ganglion from synovitis is aided by CE-MRI [162].

Suppressing the signal from fat may enhance the diagnostic yield of some pulse sequences [220]. Fat suppression may be performed using spectrally selective RF pulses, a phase-dependent method (eg, the Dixon technique), or a STIR sequence [221-224]. The latter techniques may be necessary on low-field systems [70,141].

In experimental studies, quantitative MRI has been applied to carpal tunnel syndrome and may aid in diagnosis and staging. Reported techniques include measurement of median nerve cross-sectional area [94], measurement of carpal tunnel retinacular bowing [93,95,97], and diffusion tensor imaging of the median nerve [96]. Bone age determination by grading epiphyseal fusion at the wrist may allow assessment of skeletal maturity without the use of ionizing radiation [225-228].

Parallel acceleration techniques provide the ability to increase the speed of wrist MRI, limiting issues that can arise during scanning such as patient motion and discomfort [195,229,230]. Although parallel imaging does result in a decrease of SNR, this can be overcome through the use of high field MRI (3T) [195]. Various techniques can minimize artifacts that reduce image quality. Aliasing is reduced or eliminated by reorienting the extremity or phase-encoding direction or by the use of phase oversampling [231]. Gentle immobilization combined with patient comfort measures best controls involuntary motion. Presaturation pulses or gradient moment nulling will reduce ghosting artifacts from flowing blood and other periodic motion [231,232]. Motion artifacts can also be reduced by using faster image methods, such as parallel imaging, that reduce overall scan time per imaging sequence. Radial k-space sampling is another imaging strategy to reduce motion and pulsation artifacts.

Chemical shift artifact is potentially greater at higher field strengths and may be reduced by an increase in the receiver bandwidth [174,231]. Magnetic susceptibility artifacts, which originate from heterogeneity of the local field, are also more severe at higher field strengths, adjacent to metallic implants and foreign bodies, and when using gradient-recalled echo pulse sequences. Avoiding gradient-recalled 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 [231]. Increasing the receiver bandwidth will also decrease susceptibility artifacts at the cost of a reduction in SNR. Additional proprietary metal-reduction sequences adopted by several vendors can assist in further reducing ferromagnetic artifact around metallic implants [233-235]. Magic angle artifacts can be avoided by aligning collagen-containing structures such as tendons with the main magnetic field, as opposed to alignment oblique to the main magnetic field.

It is the responsibility of the supervising physician to determine whether additional 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 direct MR arthrography with the intra-articular injection of gadolinium chelates (off-label use) [236], 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 [237].

At a minimum, the report should address the condition of the major wrist ligaments, TFCC, tendons, and bones. In selected cases, a description of findings in the bone marrow, synovium, joints, articular cartilage, retinacula, intrinsic muscles, carpal tunnel, Guyon's canal, neurovascular structures, and subcutaneous tissue would be appropriate. The report should use standard anatomic nomenclature, precise terms, and anatomic localization for describing identified abnormalities whenever possible.

VII. EQUIPMENT SPECIFICATIONS

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 *Position Statement on QC & Improvement, Safety, Infection Control*, *and Patient Education* on the ACR website (http://www.acr.org/guidelines).

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 [167,168,238]. Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination [239].

Equipment monitoring should be in accordance with the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging (MRI) Equipment [240].

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