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Each practice parameter and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review and approval. The practice parameters and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice parameter and technical standard by those entities not providing these services is not authorized.

2015 (Resolution 9)*

ACR–SAR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF MAGNETIC RESONANCE (MR) ENTEROGRAPHY

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 care¹. 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, ___ 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

Magnetic resonance enterography (MRE) is a proven and useful tool for the diagnosis, assessment of severity and complications, and follow-up of diseases of the bowel [1-9]. MRE is especially useful in patients with inflammatory bowel disease (IBD). MRE is a noninvasive test that does not employ ionizing radiation. For these reasons MRE may be considered a primary imaging modality for patients, especially the pediatric and young adult population, with IBD that require repeated imaging for disease assessment and therapeutic monitoring [10,11]. Performance of MRE requires adequate technical and clinical expertise and may not be appropriate for routine use in centers that do not possess this skillset.

II. INDICATIONS

Indications for MRE include, but are not limited to, the following:

1. Diagnosis of IBD, including assessment of disease activity and extent
2. Follow-up of known IBD, including assessment of disease activity and response to therapeutic intervention
3. Evaluation of suspected IBD-related complications, such as stricture or penetrating disease (eg, fistula or abscess)
4. Differentiation of Crohn disease from ulcerative colitis in children with “indeterminate colitis”
5. Nonemergent evaluation of suspected bowel disease with prior negative computed tomography (CT) examination and/or endoscopy, or in place of these other tests, and including a variety of processes, such as bowel obstruction or non-IBD enteritis (eg, due to infection or vasculitis)
6. Evaluation of polyposis syndromes and small-bowel mass(es)

MRE protocols are specifically tailored to allow detailed assessment of the small intestine. However, in some IBD patients, additional evaluation of IBD-related diseases or conditions may be desired at the time of MRE. Variations in MRE scanning protocol, usually requiring added pulse sequences, can allow for concurrent appraisal of the pancreaticobiliary tree (eg, in the setting of known or suspected sclerosing cholangitis), perianal/perineal region (eg, in the setting of known or suspected perianal fistula or abscess), and sacroiliac joints. Although additional imaging will lengthen the MRE examination, this approach may be desired when imaging is to be performed under sedation or general anesthesia (eg, in the pediatric population). However, combined studies should be performed in a manner that does not adversely affect image quality or overall diagnostic performance of either exam.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR Practice Parameter for Performing and Interpreting Magnetic Resonance Imaging \[12\]](#).

IV. SAFETY GUIDELINES AND POSSIBLE CONTRAINDICATIONS

See the [ACR Practice Parameter for Performing and Interpreting Magnetic Resonance Imaging \[12\]](#), the [ACR Guidance Document on MR Safe Practices \[13\]](#) and the [ACR Manual on Contrast Media \[14\]](#).

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 magnetic resonance imaging (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 the 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 MRE 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 and complications). Additional information regarding the specific reason for the

examination or a provisional diagnosis would be helpful and may at times be needed 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 scope of practice requirements as established by individual states (ACR Resolution 35, adopted in 2006).

The supervising physician must also understand the pulse sequences that are used and their imaging appearance, including the appearance of image artifacts. Standardized imaging protocols should be established but may be 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 individuals who may be at risk by exposure to the MR environment.

The majority of MRE examinations require the administration of intravenous (IV) contrast media [15,16]. 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](#) [17]). Noncontrast examinations may be considered in select cases where the presence/absence of active bowel inflammation is the only clinical question and it is felt that the clinical question may be resolved with T2-weighted (T2W) fat-suppressed sequences or diffusion-weighted imaging (DWI) [18-20]. Noncontrast examination may also be considered in patients with contraindications to IV contrast administration, such as pregnancy or diminished renal function.

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. Physicians working in or near the MRI area must have current training in MRI safety, preferably Level 2 training [13], as well as the management of contrast reactions.

C. Patient preparation

Bowel preparation is generally regarded as helpful for improving diagnostic performance of MRE [21-24]. The goal of bowel preparation is to 1) achieve maximal distension of bowel loops to improve visibility of luminal disease; 2) reduce bowel peristaltic activity to improve diagnostic quality of motion-sensitive MR sequences; and 3) displace air within bowel loops that can cause susceptibility artifact on gradient-echo sequences.

Oral contrast may be administered to patients prior to MRE to improve small-bowel distension. Patients may be asked to fast 4–6 hours prior to the examination to improve compliance with ingestion of enteric contrast preparations. Though the types and volumes of enteric contrast may vary across centers, oral contrast agents should provide some osmotic effect to prevent water absorption by the gut, and a viscosity agent to promote distension. In addition, the generally favored contrast agents demonstrate bright signal on T2W images and dark signal on T1-weighted (T1W) images, to achieve maximum contrast with the bowel wall, especially on T1W postcontrast sequences; the bowel wall will enhance, and the distended lumen will remain low signal [25-27]. Patient compliance with enteric contrast (especially pediatric patients) can be improved by contrast refrigeration and flavor additives, although caution should be employed with color additives if contemporaneous endoscopy is planned. A defined time delay from administration of oral contrast to imaging

allows for adequate distal passage of contrast prior to image acquisition. The amount of contrast and the specified time delay may vary according to center-specific experience. A recommendation is to follow prescriptions as used for CT oral contrast administration at the corresponding imaging facility. Rectal contrast may assist in visualization of the ileocecal junction [25].

Antiperistalsis medications may also be administered prior to and during the imaging exam. An oral, over-the-counter liquid anticholinergic agent may be mixed with the patient's enteric contrast to reduce bowel motility [28-31]. Administration of intravenous glucagon as a spasmolytic agent is a commonly employed method to reduce bowel motion artifact [31]. However, due to the short acting half-life of glucagon, it is recommended that it be administered immediately prior to motion sensitive sequences (typically T1W dynamic enhanced sequences), which may require interruption of image acquisition; both intramuscular (IM) and IV routes of administration are available. IM administration is longer-lasting but less reliable [32]. Evaluation for any potential contraindications or drug interactions should be investigated prior to administration.

Enteroclysis is an invasive method for improving small-bowel distension through intubation of the jejunum with a nasojejunal feeding tube and direct administration of enteric contrast through the tube [23,33]. Though enteroclysis may provide increased small-bowel distension compared to routine oral contrast administration [33], the impact on clinical decision making pathways has not been well-documented [34]. For this reason, enteroclysis is not considered an absolute requirement for routine applications of MRE. Further, dedicated colon cleansing and administration of rectal contrast is another potential patient preparation step that may be considered on a case-by-case basis [35,36].

D. Examination Technique

A phased array surface coil should be used unless precluded by patient body habitus. The field of view should be selected to cover as much of the bowel as possible while providing the highest possible signal-to-noise ratio with adequate spatial resolution. The patient may be imaged prone or supine. Although some centers have found prone imaging to improve bowel motion effects and bowel separation, there is not a consensus on this point, and there are patients who will prefer supine positioning for comfort. Adequate performance of MRE requires imaging in both the axial and coronal planes; imaging in the coronal plane is a key feature of MRE, allowing for maximum visualization of bowel loops in each slice, with optimum display of the terminal ileum. For most applications, MRE should include both T1W and T2W images [9,15,37-39].

T2W imaging may be performed with an accelerated spin-echo sequence (turbo-spin echo (TSE) or fast-spin echo (FSE)), gradient-echo (GRE) sequence, or a hybrid gradient and spin-echo (GRASE) technique. Given the motion effects of contracting bowel that cannot be corrected with breath-holding or triggering techniques, motion insensitive T2W imaging, with acquisition of all necessary phase lines in one TR interval ("single shot" technique), is the most reliable method for T2W imaging of the bowel. Slice thickness is typically 5–7 mm, and interslice gap should not exceed 10% of the slice thickness.

T2W imaging with fat suppression is a key component of MRE for evaluation of active inflammation. Fat suppression may be accomplished through a variety of techniques, including short tau inversion recovery (STIR), chemically selective fat saturation, water excitation or Dixon-based methods. Spectral adiabatic inversion recovery (SPAIR) fat suppression is a newer technique that combines elements of both inversion recovery and chemical fat-suppression techniques to provide an extremely reliable and robust degree of fat suppression while continuing to preserve water signal [20,40,41].

T1W imaging may be performed using gradient-echo or accelerated spin-echo (TSE or FSE) methods. Three-dimensional (3-D) image acquisition methods are available for both gradient-echo and spin-echo sequences, allowing for higher through-plane resolution, improvements in SNR and more homogeneous fat suppression. T1W 3-D gradient-echo acquisitions have the advantage of rapid acquisitions within a breath-hold, reducing breathing-motion artifact without the need for time-consuming respiratory navigation and triggering techniques. Newer radial acquisition methods such as radial 3-D GRE sequences are also available for patients that are unable to breath-hold at all [42,43].

Intravenous contrast enhancement with gadolinium chelates is important for comprehensive MRE, especially for accurate diagnosis and delineation of chronic bowel disease and fibrotic strictures, abscesses, and perianal fistulas. Every attempt should be made to use intravenous contrast except when there is a) no intravenous

access; b) history of prior allergic-type reactions to gadolinium chelates and the patient has not been premedicated; c) relative contraindication to gadolinium chelates (such as pregnancy); or d) known or suspected nephrogenic systemic fibrosis (NSF) or particular concerns regarding NSF risk that may outweigh the benefits of the MRE exam. Venous and delayed phase postcontrast images, in both the axial and coronal plane, are also key sequences to depict fibrosis within the bowel wall, which will appear thickened and will retain contrast [1,3,44-46]. Similarly, late enhancement is a feature of fibrotic adhesions that may be associated with tethered bowel loops or fistula [47].

Additional MR sequences, although considered optional, may provide added value to bowel imaging. Dynamic, real-time MR imaging of the bowel may be obtained utilizing a heavily T2W coronal slab or a single-shot steady-state free precession sequence centered over a region of interest [48-50]; repeated image acquisitions over time with these techniques may be used to produce “real-time” cine imaging of the bowel to aid in evaluation of any potential functional significance of fibrotic strictures. However, even in the absence of real-time cine images, comparison of different sequences that are acquired at different time points during the study acquisition is helpful to discern bowel peristalsis from fibrotic stricture. DWI and quantitative perfusion sequences are additional MRI techniques that may be performed for bowel imaging [18,51-55]. DWI detects abnormally restricted water motion, and these images can show areas of inflamed bowel wall and adjacent soft tissue. Quantitative perfusion may be able to help discriminate between inflammation or fibrosis in a region of abnormally thickened bowel wall, where inflammation leads to increased vascularity and accelerated contrast arterial phase enhancement.

VI. DOCUMENTATION

Reporting should be in accordance with the [ACR Practice Parameter for Communication of Diagnostic Imaging Findings \[56\]](#).

VII. EQUIPMENT SPECIFICATION

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 magnetic field strength (dB/dt), maximum radiofrequency power deposition (specific absorption rate), and maximum acoustic noise levels. Additional considerations include the use of surface coils that can provide coverage of the entire abdomen and pelvis. In addition, it may be commonly necessary to use at least 2 fields-of-view to capture all of the abdomen and pelvis. Acquisition and postprocessing of these images may be facilitated by systems with specific software that allows merging of at least 2 imaging fields.

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 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 the potential hazards associated with MRI examination of the patient as well as to others in the immediate area. Screening forms must also be provided to detect those patients who may be at risk for adverse events associated with the MRI examination.

Equipment monitoring should be in accordance with the [ACR-AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Magnetic Resonance Imaging \(MRI\) Equipment \[57\]](#).

ACKNOWLEDGEMENTS

This practice parameter was revised according to the process described under the heading *The Process for Developing ACR Practice Parameters and Technical Standards* on the ACR website (<http://www.acr.org/guidelines>) by the Committee on Body Imaging (Abdominal) of the Commission on Body Imaging and by the Committee on Practice Parameters – Pediatric Radiology of the Commission on Pediatric Radiology, in collaboration with the SAR and the SPR.

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Development Chronology for this Practice Parameter

2015 (Resolution 9)