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Revised 2016 (Resolution 22)*

ACR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF COMPUTED TOMOGRAPHY (CT) OF THE ABDOMEN AND COMPUTED TOMOGRAPHY (CT) OF THE PELVIS

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. 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, 761 N.W.2d 1 (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 collaboratively by the American College of Radiology (ACR) and the Society for Pediatric Radiology (SPR).

Computed tomography (CT) is a radiologic modality that utilizes ionizing radiation to obtain cross-sectional images (nonhelical CT) or volumetric data sets (helical CT). The acquired images may also be reprocessed to produce images in many anatomic planes or in 3 dimensions to view entire anatomic volumes. Optimal performance of CT requires knowledge of anatomy and pathophysiology, familiarity with the basic physics and techniques of CT, and knowledge of radiation safety. This practice parameter outlines the principles for performing high-quality diagnostic abdominal CT and/or pelvic CT.

II. INDICATIONS AND CONTRAINDICATIONS

A. Indications for abdominal CT and/or pelvic CT examinations include, but are not limited to:

1. Evaluation of abdominal, flank, or pelvic pain, including evaluation of suspected or known urinary calculi [1-3] and appendicitis [4-6]
2. Evaluation of abdominal or pelvic trauma [7-11]
3. Evaluation of renal and adrenal masses and of urinary tract abnormalities with CT urography [12-16]
4. Evaluation of known or suspected abdominal or pelvic masses or fluid collections, including gynecological masses [17-20]
5. Evaluation of primary or metastatic malignancies, including lesion characterization (eg, focal liver lesion) [21-24], staging, and treatment monitoring
6. Surveillance following locoregional therapies in abdominal malignancies, including percutaneous ablation, intra-arterial therapies (transarterial chemoembolization, selective interstitial radiation therapy), and targeted image-guided radiation therapy [25-28]
7. Assessment for recurrence of tumors following surgical resection [29-31]
8. Detection of complications following abdominal and pelvic surgery, eg, abscess, lymphocele, radiation change, and fistula/sinus tract formation [32-36]
9. Evaluation of diffuse liver disease (eg, cirrhosis, steatosis, iron deposition disease [37-40]) and biliary system, including CT cholangiography [41-43]
10. Evaluation of abdominal or pelvic inflammatory processes, including inflammatory bowel disease, infectious bowel disease and its complications, without or with CT enterography [44-48]
11. Assessment of abnormalities of pelvic or vaginal vascular structures [49-52]; noninvasive angiography of the aorta and its branches and noninvasive venography [53-56]
12. Clarification of findings from other imaging studies or laboratory abnormalities
13. Evaluation of known or suspected congenital abnormalities of abdominal or pelvic organs [57-59]
14. Evaluation for bowel obstruction or GI bleeding [60-64]
15. Screening and diagnostic evaluation for colonic polyps and cancers with CT colonography [65-69]
16. Guidance for interventional or therapeutic procedures within the abdomen or pelvis [70-75]
17. Follow-up evaluation after interventional or therapeutic procedures within the abdomen or pelvis, including abscess drainage [76-79]
18. Treatment planning for radiation and chemotherapy and evaluation of tumor response to treatment, including perfusion studies [80-86]
19. Pre- and post-transplant assessment [87-92]

B. There are no absolute contraindications to abdominal CT or pelvic CT examinations. As with all procedures, the relative benefits and risks of the procedure should be evaluated before performing abdominal or pelvic CT, with and/or without the administration of intravenous iodinated contrast. Appropriate precautions should be taken to minimize patient risks, including radiation exposure and iodinated contrast delivery (see the ACR-SPR Practice Parameter for the Use of Intravascular Contrast Media [93] and the ACR Manual on Contrast Media [94]).
For the pregnant or potentially pregnant patient, see the ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation [95].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography (CT) [96].

IV. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for a CT of the abdomen and/or a CT of the pelvis 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)

A. In general, a CT examination of the abdomen includes transaxial images from just above the dome of the diaphragm to the upper margin of the sacroiliac joints with a 5-mm or less slice thickness. A CT of the pelvis extends from the iliac crest through just below the ischial tuberosities with a 5-mm or less slice thickness (see section VI). Occasionally, more inferior extension of imaging may be required to fully image pelvic structures of concern. Often, depending on the clinical indication for the study, both the abdomen and pelvis may be examined concurrently. Scans should be obtained through the entire area of interest. The scan field of view should be optimized for each patient. Scans should generally be obtained during suspended respiration but may be obtained during free breathing for certain indications, such as radiation therapy planning.

B. The primary goal of CT scanning is to obtain diagnostic information from images of sufficient quality from the task. Protocols should be optimized to give the lowest dose required to achieve appropriate image quality for a given task. This is especially important for radiosensitive groups, such as pediatric patients. Dose-reduction techniques should be considered when optimizing protocols. These techniques include, but are not limited to, automatic exposure control, iterative reconstruction and noise reduction algorithms, and automatic tube voltage selection. In certain cases, it may be appropriate to limit the area exposed and focus only on the area or organs of concern in order to limit the radiation dose. Similarly, it may be appropriate for certain tasks, such as evaluating only skeletal structure, to use high-noise/low-dose protocols.

C. In addition to axial images, at least 1 multiplanar reformation, such as coronal images, should be reconstructed if feasible [97-101]. Additionally, sagittal or more complex oblique planes may be constructed from the source-image data to answer specific clinical questions, to aid in disease visualization, or to assist in planning for interventional or surgical procedures. Additionally, 3-D reformations such as maximum intensity projection (MIP), bone subtraction, and volume-rendered reformations may be obtained to clarify specific structures for studies such as CT angiography, CT urography, CT cystography, CT colonography, CT enterography, CT cholangiography, and/or other applications deemed necessary.

D. Abdominal and/or pelvic CT examinations may be performed during and/or after administering intravenous (IV) contrast medium using appropriate injection techniques [102,103]. The majority of clinical questions for abdominal and/or pelvic CT can be appropriately answered with a single-phase study. Multiple-phase studies such
as unenhanced, arterial, portal venous, or delayed-phase scanning might be required in certain indications for improved detection and characterization of lesions such as for possible hepatocellular carcinoma, hypervascular metastases, etc. For specific indications, it may be necessary to perform a non-IV contrast-enhanced study first. Abnormal findings on an unenhanced examination may require further evaluation with contrast enhancement or an alternative imaging study if contrast medium is contraindicated. Administration of IV contrast is generally not required for certain indications such as pure evaluation of bony structures and assessment of urolithiasis.

E. An enteric agent is commonly used in abdominal and pelvis CT scans, but the choice of an enteric agent and type can be determined on a case-by-case basis. An intraluminal gastrointestinal contrast agent may be administered orally, rectally, or by nasogastric or other tube to provide adequate distention and visualization of the gastrointestinal tract. This agent may be a positive contrast agent, such as dilute barium or a water-soluble iodinated solution; a neutral contrast agent, such as water or a nonabsorbable agent with similar x-ray attenuation as water; or a negative agent, such as air or carbon dioxide.

Positive contrast material provides improved delineation of abscesses, suspected leaks, intra-abdominal tumors, and tube checks. Positive contrast may obscure the visualization of bowel wall enhancement or hypoenhancement. Positive contrast may also interfere with 3-D reformations of blood vessels. Barium agents, if used for CT, should be no more than 3% wt/wt.

Neutral enteric contrast agents provide good visualization of bowel wall hyperenhancement or hypoenhancement. A variety of agents are available. Water can be used if distention of only the proximal gastrointestinal tract is necessary. When distention of bowel beyond the proximal gastrointestinal tract is needed, contrast materials that contain materials less rapidly absorbed by the bowel can be used [104]. Neutral enteric contrast may reduce sensitivity for masses or fluid collections.

Negative enteric contrast agents are used predominantly for CT colonography but can also be used in other scenarios such as gastric or esophageal imaging [105].

F. Appropriate window width and level settings should be used to view the visceral organs, the intra-abdominal fat and muscles, the pulmonary parenchyma at the lung bases, and the osseous structures. Particular attention to window width and level settings should be paid when dual energy or low kVp is used.

G. Although many of the settings of a CT scanner are automated, a number of technical parameters remain operator dependent [106]. The supervising physician should be familiar with how individual CT settings affect radiation dose and image quality. These settings include the following:

1. Automated exposure control [107]
2. Iterative reconstruction and similar noise reduction techniques
3. Tube potential (kVp)
4. Gantry rotation time
5. Detector configuration and Z axis detector width for multidetector systems.
6. Reconstructed slice thickness and spacing
7. Pitch or table increment
8. Field of view
9. Reconstruction algorithm (kernel)

Dual-energy technique may be considered to improve diagnostic confidence, such as to reduce artifacts from metallic objects, improve contrast material conspicuity, confirm the presence of contrast material enhancement in a lesion, and potentially reduce the need for a separate unenhanced CT scan acquisition [108-115]. Low-kVp or dual-energy technique may also be used to reduce the volume of intravenous contrast required.

H. Optimizing CT examination technique requires the supervising physician to select an appropriate CT protocol based on careful review of the patient history (to include risk factors that might increase the likelihood of adverse reactions to contrast media) and clinical indications, as well as all relevant imaging studies, when available. This
optimization process may include determining whether CT examination of the abdomen, pelvis, or both is necessary.

I. Protocols may be prepared by clinical indication and anatomy to be imaged. Techniques should provide image quality consistent with the diagnostic needs of the examination at appropriate radiation dose levels [111,116-118]. For each area of interest or indication, the protocol should indicate the following:

1. The volume and type of intraluminal contrast media to be administered, the route of administration (oral, rectal, or via nasogastric, Foley catheter, or other tube), and the time intervals during which it should be delivered
2. If intravenous contrast material is used, the type, volume, rate of administration, and time delay(s) between administration and scan initiation. Bolus tracking or timing bolus should be used whenever indicated to optimize results [118-120].
3. Detector configuration
4. Pitch or table increment
5. Slice thickness
6. kVp and mAs per slice or range (minimum and maximum mAs for multidetector CT), as appropriate for adult or pediatric patients
7. Gantry rotation time
8. Automated exposure control
9. Reconstruction technique
10. Superior and inferior extent of the region of interest to be imaged
11. Reconstruction interval
12. Reconstruction kernel (algorithm)
13. Reconstruction field of view
14. Instructions for which scans/images are sent to PACS (Picture Archiving and Communication System)
15. Three-dimensional and multiplanar reconstructions, (MPR) where needed
16. For every CT examination, the information in the radiation dose report (CTDI and Dose Length Product) should be retained in the radiological record for future reference.

These protocols should be reviewed and updated periodically, and dated copies should be available to appropriate physicians and technical and administrative personnel at the facility.

V. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Parameter for Communication of Diagnostic Imaging Findings [121].

VI. EQUIPMENT SPECIFICATIONS

A. Performance Guidelines

To achieve acceptable clinical CT scans of the abdomen and/or pelvis, a CT scanner should meet or exceed the following capabilities:

1. Helical acquisition with a pitch between 0.8 and 2
2. Scan rotation time: ≤1 sec
3. Minimum slice thickness: ≤2 mm
4. Limiting spatial resolution: ≥8 lp/cm for ≥32-cm display field of view (DFOV) and ≥10 lp/cm for <24 cm DFOV

Additional CT equipment specifications for imaging of pediatric patients may be found in the ACR-ASER-SCBT-MR-SPR Practice Parameter for the Performance of Pediatric Computed Tomography (CT) [122].
B. 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. For additional information, refer to the ACR Manual on Contrast Media [94].

C. A soft-copy workstation (PACS station) review capability should be available to the radiologist. Remote viewing of images should also be available to authorized health care providers. A method should be available to transfer images outside the institution to authorized recipients.

VII. RADIATION SAFETY IN IMAGING

When possible, CT imaging of the abdomen and pelvis should consider the following to minimize radiation dose and maintain image quality:

1. Center the patient in the gantry [123-127].
2. Keep the patient’s arms above the abdomen [128,129].
3. Remove non-necessary, densely radiopaque objects from the patient.

Use low-dose CT technique for imaging scenarios such as the evaluation of nephrolithiasis, where fine detail is not needed, or when imaging younger patients <40 years old.

Radiologists, medical physicists, registered radiologist assistants, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, “as low as reasonably achievable” (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel that work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection and application of dose limits) and the principles of proper management of radiation dose to patients (justification, optimization and the use of dose reference levels) http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1578_web-57265295.pdf

Nationally developed guidelines, such as the ACR Appropriateness Criteria®, should be used to help choose the most appropriate imaging procedures to prevent unwarranted radiation exposure.

Facilities should have and adhere to policies and procedures that require varying ionizing radiation examination protocols (plain radiography, fluoroscopy, interventional radiology, CT) to take into account patient body habitus (such as patient dimensions, weight, or body mass index) to optimize the relationship between minimal radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used whenever appropriate. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available at the Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org) websites. These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be measured and patient radiation dose estimated for representative examinations and types of patients by a Qualified Medical Physicist in accordance with the applicable ACR technical standards. Regular auditing of patient dose indices should be performed by comparing the facility’s dose information with national benchmarks, such as the ACR Dose Index Registry, the NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director’s National Evaluation of X-ray Trends. (ACR Resolution 17 adopted in 2006 – revised in 2009, 2013, Resolution 52).
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).

For specific issues regarding CT quality control, see the ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography (CT) [130].

Equipment monitoring and the continuous quality control program should be in accordance with the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment [131].

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Collaborative Committee – members represent their societies in the initial and final revision of this practice parameter

ACR
Benjamin M. Yeh, MD, Chair
Avinash Kambadakone, MD
Ruedi F. Thoeni, MD
Alexander J. Towbin, MD

SPR
Arthur B. Meyers, MD
Ethan A. Smith, MD
Kristen B. Thomas, MD

Committee on Body Imaging (Abdominal)
(ACR Committee responsible for sponsoring the draft through the process)

Ruedi F. Thoeni, MD, Chair
Mahmoud M. Al-Hawary, MD
Mark E. Baker, MD, FACR
Barry D. Daly, MD, MB, BCh
Isaac R. Francis, MD, FACR
Patrick Gonzales, MD
Richard M. Gore, MD, FACR
Dean D. Maglinte, MD, FACR
Frank H. Miller, MD, FACR
Donald G. Mitchell, MD, FACR
Eric M. Rubin, MD
Scott D. Stevens, MD, FACR
William E. Torres, MD, FACR

Committee on Practice Parameters – Pediatric Radiology
(ACR Committee responsible for sponsoring the draft through the process)

Beverley Newman, MB, BCh, BSc, FACR, Chair
Lorna P. Browne, MB, BCh
Timothy J. Carmody, MD, FACR
Brian D. Coley, MD, FACR
Lee K. Collins, MD
Monica S. Epelman, MD
Lynn Ansley Fordham, MD, FACR
Kerri A. Highmore, MD
Sue C. Kaste, DO
Tal Laor, MD
Terry L. Levin, MD
Marguerite T. Parisi, MD, MS
Sumit Pruthi, MBBS
Nancy K. Rollins, MD
Pallavi Sagar, MD

Lincoln L. Berland, MD, FACR, Chair, Commission on Body Imaging
Marta Hernanz-Schulman, MD, FACR, Chair, Commission on Pediatric Imaging
Jacqueline A. Bello, MD, FACR, Chair, Commission on Quality and Safety
Matthew S. Pollack, MD, FACR, Chair, Committee on Practice Parameters and Technical Standards

Comments Reconciliation Committee
Joseph G. Cernigliaro, MD, FACR, Chair
Eric J. Stern, MD, Co-Chair
Jacqueline A. Bello, MD, FACR
Lincoln L. Berland, MD, FACR
Sabina Choudhry, MB, BS
Marta Hernanz-Schulman, MD, FACR
William T. Herrington, MD, FACR
Avinash Kambadakone, MD
Paul A. Larson, MD, FACR
Arthur B. Meyers, MD
Beverley Newman, MB, BCh, BSc, FACR
Matthew S. Pollack, MD, FACR
William F. Sensakovic, BA, BS, PhD
Ethan M. Smith, MD
Timothy L. Swan, MD, FACR
Ruedi F. Thoeni, MD
Kristen B. Thomas, MD
Alexander J. Towbin, MD
Benjamin M. Yeh, MD

REFERENCES


*Practice parameters and technical standards are published annually with an effective date of October 1 in the year in which amended, revised or approved by the ACR Council. For practice parameters and technical standards published before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

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