Revised 2011 (Resolution 32)*

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

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They 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 cautions against the use of these guidelines 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 physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, 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 the guidelines 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 the guidelines. However, a practitioner who employs an approach substantially different from these guidelines 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 these guidelines 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 these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This guideline 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 three 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 guideline outlines the principles for performing high-quality diagnostic abdominal CT and/or pelvic CT.

II. INDICATIONS AND CONTRAINDICATIONS

A. Indications for abdominal CT 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 renal and adrenal masses and of urinary tract abnormalities with CT urography [7-10].
3. Evaluation of known or suspected abdominal or pelvic masses or fluid collections, including gynecological masses [11-13].
4. Evaluation of primary or metastatic malignancies, including lesion characterization, e.g., focal liver lesion [14-17].
5. Evaluation of diffuse liver disease (e.g., steatosis, iron deposition disease, cirrhosis [18-19]) and biliary system, including CT cholangiography [20].
6. Assessment for recurrence of tumors following surgical resection [21-22].
7. Detection of complications following abdominal and pelvic surgery, e.g., abscess, lymphocele, radiation change, and fistula/sinus tract formation [23-26].
8. Evaluation of abdominal or pelvic inflammatory processes**,** including inflammatory bowel disease, infectious bowel disease and its complications, without or with CT enterography [27-29].
9. Assessment of abnormalities of abdominal or pelvic vascular structures [30-32].
10. Evaluation of abdominal or pelvic trauma [33-36].
11. Clarification of findings from other imaging studies or laboratory abnormalities.
12. Evaluation of known or suspected congenital abnormalities of abdominal or pelvic organs [37-38].
13. Evaluation for small bowel or large bowel obstruction [39-40].
14. Screening for colonic polyps and cancers with CT colonography [41-42].
15. Guidance for interventional or therapeutic procedures within the abdomen or pelvis [43-45].
16. Treatment planning for radiation and chemotherapy and evaluation of tumor response to treatment, including perfusion studies [46-50].
17. Pre- and post-transplant assessment [51-52].
18. Noninvasive angiography of the aorta and its branches and noninvasive venography [53-54].

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. (See the ACR–SPR Practice Guideline for the Use of Intravascular Contrast Media and the ACR Manual on Contrast Media.)

For the pregnant or potentially pregnant patient, see the ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Computed Tomography (CT).

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 5 mm or less slice thickness. A CT of the pelvis extends from the iliac crest through just below the ischial tuberosities with 5 mm or less slice thickness (see section VI). Often, depending on the clinical indication for the study, both the abdomen and pelvis may be examined concurrently. 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. This is especially advised in patients with multiple CT studies and follow-up examinations. An adequate study may be performed with single detector helical technique, but multidetector (including wide detector) scanners are now preferred. Beam pitch should not routinely exceed 2:1 for helical scanners.

B. In addition to axial images, images in coronal, sagittal, or other 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, the imaging information may be displayed to demonstrate specific structures such as in CT angiography, CT urography, CT cystography, CT colonography, CT enterography, CT cholangiography, and/or other applications deemed necessary. Such applications are best performed based on data acquired with multidetector CT.

C. Some abdominal and/or pelvic CT examinations may be performed with multiple acquisitions. All acquisitions are best obtained in the same suspended state of respiration if possible. In general, the fewest number of acquisitions needed to answer the clinical question should be obtained. This is particularly important when imaging children and adolescents. The vast majority of clinical questions for abdominal and/or pelvic CT in children can be appropriately answered with a single-phase study. For radiation treatment planning, examinations should be obtained during normal respiration. Scans should be obtained through the entire area of interest. The scan field of view should be optimized for each patient. Exposure parameters should be optimized for each acquisition to minimize radiation dose while providing the necessary information. Scanner specific dose modulation programs may be helpful for this purpose. Radiation dose reduction is particularly important in the pediatric population and young adults [55].

D. An intraluminal gastrointestinal contrast agent may be administered orally, rectally, or by nasogastric or other tube to provide adequate visualization of the gastrointestinal tract unless medically contraindicated or unnecessary for the clinical indication. This 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, or a negative agent such as air or carbon dioxide.

E. Abdominal and/or pelvic CT examinations may be performed during and/or after administering intravenous (IV) contrast medium, using appropriate injection techniques [56-57]. 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.

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.

G. Although many of the operations of a CT scanner are automated, a number of technical parameters remain operator-dependent [58]. Because these parameters can significantly affect the diagnostic quality of a CT examination, the supervising physician must become familiar with the following:

1. Radiation exposure factors.
2. Collimation.
3. Table increment or pitch.
4. Field of view.
5. Window settings.
6. Reconstruction algorithm.
7. Image reconstruction interval.
8. Detector configuration for multidetector systems.
9. Display slice width for multidetector systems.
10. Tube current dose modulation setting.
11. Radiation dose report.

H. Optimizing CT examination technique requires the supervising physician to develop 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 if CT examination of the abdomen, pelvis, or both is necessary.

I. Protocols may be prepared by region of interest and medical indication. Techniques should be selected that provide image quality consistent with the diagnostic needs of the examination at acceptable radiation dose levels. For each area of interest or indication, the protocol should indicate the following:

1. The volume and type of gastrointestinal contrast media to be administered, the route of administration (oral, rectal, or via nasogastric 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 between administration and scan initiation. Bolus tracking should be used whenever indicated to optimize results [59-61].
3. Detector configuration.
4. Table increment and pitch.
5. Slice thickness.
6. Reconstruction interval.
7. Reconstruction kernel (algorithm).
8. kVp and mAs per slice or range (minimum and maximum mAs for multidetector CT) as appropriate for adult or pediatric patients.
9. Noise index (for multidetector CT).
10. Superior and inferior extent of the region of interest to be imaged.

11. Protocols for sending images to PACS (Picture Archiving and Communication System) (e.g., scans in original slice thickness and/or reformations in axial plane at larger slice thickness in the coronal, sagittal, and other oblique planes), and MIPS (Medical Image Processing System) as needed.
12. 3D reconstructions where needed.
13. For every CT examination, the information in the radiation dose report (CTDI and Dose Length Product) should be retained in the radiological record (sent to PACS) for future reference.

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

V. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

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 1 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.

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.

C. A soft-copy workstation (PACS station) review capability should be available to radiologist and clinicians. CD or DVD capability also should be provided.

VII. EQUIPMENT QUALITY CONTROL

The quality control program for CT equipment should be designed to minimize patient, personnel, and public radiation risks and to maximize the quality of the diagnostic information. The program should be supervised by a medical physicist. Each imaging facility should have documented policies and procedures that include:

1. A list of tests to be performed and the frequency of performance.
2. A list identifying which individual or group will perform the tests.
3. A written description of the procedure that will be used for each test, including the technique factors to be employed, the equipment to be used for testing, the acceptability limits of each test, and sample records from each test.
4. Periodic tests for CT technologists to assure compliance with implementation of dose reduction MDCT protocols and understanding of principles [62].

VIII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, radiologic technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as "as low as reasonably achievable (ALARA)."

Facilities, in consultation with the medical physicist, should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary examination protocols to take into account patient body habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active; if not; manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Periodically, radiation exposures should be measured and patient radiation doses estimated by a medical physicist in accordance with the appropriate ACR Technical Standard. (ACR Resolution 17, adopted in 2006 – revised in 2009, Resolution 11)

IX. 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 web site (http://www.acr.org/guidelines).

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

Equipment performance monitoring should be in accordance with the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment.

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