ACR–ASNR PRACTICE GUIDELINE FOR THE PERFORMANCE OF COMPUTED TOMOGRAPHY (CT) OF THE BRAIN

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 developed collaboratively by the American College of Radiology (ACR) and the American Society of Neuroradiology (ASNR).

Computed tomography (CT) is a technology extensively used in neuroradiology that produces cross-sectional displays using ionizing radiation to generate images resulting from X-ray absorption by the specific tissues examined. CT offers a high degree of utility in the examination of the brain. This guideline outlines the principles for performing high-quality CT imaging of the brain in pediatric and adult patients, including advanced applications such as CT perfusion, CT volumetry, CT angiography, and CT venography.

II. INDICATIONS

Indications for CT of the brain include, but are not limited to:

A. Primary Indications
   1. Acute head trauma.
   2. Suspected acute intracranial hemorrhage.
3. Vascular occlusive disease or vasculitis (including use of CT angiography and/or venography).
4. Aneurysm evaluation.
5. Detection or evaluation of calcification.
6. Immediate postoperative evaluation following surgical treatment of tumor, intracranial hemorrhage, or hemorrhagic lesions.
7. Treated or untreated vascular lesions.
8. Suspected shunt malfunctions, or shunt revisions.
9. Mental status change.
10. Increased intracranial pressure.
11. Headache.
13. Suspected intracranial infection.
14. Suspected hydrocephalus.
15. Congenital lesions (such as, but not limited to, craniosynostosis, macrocephaly, and microcephaly).
17. Brain herniation.
18. Suspected mass or tumor.

B. Secondary Indications
1. When magnetic resonance imaging (MRI) imaging is unavailable or contraindicated, or if the supervising physician deems CT to be appropriate.
2. Diplopia.
3. Cranial nerve dysfunction.
4. Seizures.
5. Apnea.
7. Ataxia.
8. Susicion of neurodegenerative disease.
10. Neuroendocrine dysfunction.
11. Encephalitis.
12. Drug toxicity.
13. Cortical dysplasia, and migration anomalies or other morphologic brain abnormalities.

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 Diagnostic Computed Tomography (CT).

IV. 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 should be familiar with relevant ancillary studies that the patient may have undergone. (See the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.) The physician performing CT interpretation must have a clear understanding and knowledge of the anatomy and pathophysiology relevant to the examination.

The written or electronic request for CT of the brain 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. General Considerations

CT protocols for brain imaging should be designed to answer the specific clinical question. The supervising physician should be familiar with the indications for each examination, relevant patient history, potential adverse reactions to contrast media, exposure factors, window and center settings, field of view, collimation, slice intervals, slice spacing (table increment) or pitch, and image reconstruction algorithms. Protocols should be reviewed and updated periodically to optimize the examination.

B. Brain Imaging

CT brain imaging may be performed with a sequential single-slice technique, multislice helical (spiral) protocol, or multidetector multislice algorithm. For CT of the brain, contiguous or overlapping axial slices should be acquired with a slice thickness of no greater than 5 mm. In the setting of trauma, images should be obtained and/or reviewed at window settings appropriate for demonstrating brain and bone abnormalities as well as
small subdural hematomas and soft tissue lesions (subdural windows). For imaging of the cranial base, an axial slice thickness as thin as possible, but no greater than 3 mm with spiral techniques and 2 mm with multidetector and nonspiral techniques, should be used for 2D reformattting or for 3D reconstruction.

C. Contrast Studies

Certain indications require administration of intravenous (IV) contrast media or intrathecal contrast (e.g., cisternography) during imaging of the brain. Intravenous contrast enhancement should be performed using appropriate injection protocols and in accordance with the ACR–SPR Practice Guideline for the Use of Intravascular Contrast Media. Cerebrospinal fluid (CSF) contrast administration requires use of nonionic agents approved for intrathecal use and should be performed with regard to applicable guidelines as outlined in the ACR–ASNR Practice Guideline for the Performance of Myelography and Cisternography.

D. Advanced Applications

In addition to directly acquired axial images, reformatted images in coronal, sagittal, or other more complex planes may be constructed from the axial data set to answer specific clinical questions, or the images may be manipulated to allow selective visualization of specific tissues such as in CT perfusion, CT volumetry, CT angiography, or CT venography. Such applications are better performed with helical data sets using very thin slice thickness and overlapping reconstruction rather than routine axial sequential data. See the ACR–ASNR Practice Guideline for the Performance of Computed Tomography (CT) Perfusion in Neuradiologic Imaging.

V. DOCUMENTATION

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

VI. EQUIPMENT SPECIFICATIONS

A. Performance Standards

To achieve acceptable clinical CT scans of the brain, the CT scanner should meet or exceed the following specifications:

1. Scan times: per slice or image not more than 2 seconds.
2. Slice thickness: minimum slice thickness 2 mm or less.
3. Interscan delay: not more than 4 seconds (may be longer if intravascular contrast media is not used).
4. Limiting spatial resolution: must be measured to verify that it meets the unit manufacturer’s specifications. Limiting spatial resolution should be \( \geq 10 \) lp/cm for a \(<24\) cm display field of view (DFOV).
5. Table pitch: no greater than 2:1 for most CT scanners.
6. For advanced applications (e.g., perfusion imaging or CTA), cine-capable scanners are preferable with tube rotation \( \leq 1\) second and continuous cine imaging \( \geq 60\) seconds. See the ACR–ASNR Practice Guideline for the Performance of Computed Tomography (CT) Perfusion in Neuradiologic Imaging.

B. Patient monitoring equipment and facilities for cardiopulmonary resuscitation, including vital signs monitoring equipment, support equipment, should be immediately available.

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 or sizes in the patient populations.

Radiologists, technologists, and staff members should be able to assist with procedures, patient monitoring, and patient support. A written policy should be in place for dealing with emergencies such as cardiopulmonary arrest.

VII. 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)

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 web page (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 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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Suggested Reading (Additional articles that are not cited in the document but that the committee recommends for further reading on this topic)

41. Prabhakar R, Haresh KP, Ganesh T, Joshi RC, Julka PK, Rath GK. Comparison of computed tomography...

*Guidelines and 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 guidelines and standards published before 1999, the effective date was January 1 following the year in which the guideline or standard was amended, revised, or approved by the ACR Council.

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