ACR–ASNR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF COMPUTED TOMOGRAPHY (CT) OF THE EXTRACRANIAL HEAD AND NECK

The American College of Radiology, with more than 40,000 members, is the principal organization of radiologists, radiation oncologists, and clinical medical physicists in the United States. The College is a nonprofit professional society whose primary purposes are to advance the science of radiology, improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists, radiation oncologists, medical physicists, and persons practicing in allied professional fields.

The American College of Radiology will periodically define new practice parameters and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

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.

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 considering 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 variables such as the condition of the patient, limitations of available resources, or advances in knowledge or technology after publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document may consider documenting in the patient record information sufficient to explain the approach taken.

The practice of medicine involves the science, and 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 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*, 831 N.W.2d 826 (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), the American Society of Neuroradiology (ASNR), and the Society for Pediatric Radiology (SPR).

Computed tomography (CT) is a radiologic modality for evaluating a variety of disorders involving the extracranial head and neck. CT should be performed only for a valid medical reason and with the minimum radiation dose necessary to achieve an optimal study. Additional or specialized examinations may be required. Although it is not possible to detect all abnormalities using CT, adherence to the following parameters will increase the probability of their detection.

II. INDICATIONS

A. Indications for CT of the soft tissues of the extracranial head and neck include, but are not limited to [1-37]:

1. Congenital anomalies
2. Benign and malignant neoplasms
3. Acute and chronic infectious or inflammatory disease
4. Trauma
5. Vascular pathology, hemorrhage/epistaxis
6. Radiation therapy treatment planning
7. Follow-up after surgery, chemotherapy, or radiation therapy
8. Preoperative and intraoperative planning and/or guidance, including minimally invasive procedures
9. Thyroid abnormalities, most commonly preoperative evaluation of goiter and advanced-stage thyroid cancer (note: ultrasound is the standard evaluation of intrathyroidal nodules to determine need for fine-needle aspiration (FNA) and routine preoperative evaluation of differentiated thyroid cancer) [38].
10. Parathyroid adenoma localization
11. Cranial nerve deficits
12. Evaluation of palpable masses

B. Indications for CT of the paranasal sinuses include, but are not limited to [11,35,39-52]:
1. Congenital anomalies
2. Benign and malignant neoplasms
3. Acute and chronic infectious or inflammatory disease
4. Trauma
5. Vascular pathology or evaluation of hemorrhage/epistaxis
6. Radiation therapy treatment planning
7. Follow-up after surgery, chemotherapy, or radiation therapy
8. Preoperative and intraoperative planning and/or guidance, including minimally invasive procedures
9. Complications of sinusitis and sinus surgeries
10. Fibro-osseous lesions of the midface and sinonasal region

C. Indications for CT of the orbits include, but are not limited to [35,40-42,46,49,52-57]:

1. Congenital anomalies
2. Benign and malignant neoplasms
3. Acute and chronic infectious or inflammatory disease
4. Trauma
5. Vascular pathology or hemorrhage
6. Radiation therapy treatment planning
7. Follow-up after surgery, chemotherapy, or radiation therapy
8. Preoperative and intraoperative planning and/or guidance, including minimally invasive procedures
9. Complications of sinusitis and sinus surgeries
10. Fibro-osseous lesions

11. Proptosis
12. Thyroid orbitopathy
13. Foreign body
14. Diplopia
15. Loss of vision

D. Indications for CT of the temporal bone include, but are not limited to [35,58,59]:

1. Congenital anomalies
2. Benign and malignant neoplasms
3. Acute and chronic infectious or inflammatory disease
4. Trauma
5. Vascular pathology or hemorrhage
6. Radiation therapy treatment planning
7. Follow-up after surgery, chemotherapy, or radiation therapy
8. Preoperative and intraoperative planning and/or guidance, including minimally invasive procedures
9. Conductive or sensorineural hearing loss
10. Preoperative evaluation prior to mastoidectomy
11. Preoperative or postoperative evaluation for auditory devices
12. Suspected inner ear disease

For the pregnant or potentially pregnant patient, see the ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation [60].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography (CT) [61].

IV. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for CT of the head and neck 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 – revised in 2016, Resolution 12-b)

Head and neck CT protocols require close attention and development by the supervising physician according to specified indications, and by incorporating ACR Appropriateness Criteria®. Protocols should be reviewed periodically in order for the examinations to be optimized for image quality and opportunities for dose reduction. Single-phase CT (noncontrast or postcontrast) is sufficient in the vast majority of cases [62]. The supervising physician should be familiar with the indications for each examination, relevant patient history, potential adverse reactions to contrast media, exposure factors, field of view (FOV), collimation, slice intervals, and reconstruction algorithms.

When available, dual-energy CT (DECT) may provide additional information beyond single-energy CT examinations of the neck. DECT reconstructed at low energy levels may improve visualization of primary squamous cell carcinoma [63]. DECT may also improve accuracy of assessment of laryngeal cartilage invasion [64,65]. Metal artifact can be decreased with DECT reconstructed at higher energy levels [66,67].

With multidetector CT scanners, high-quality images should be reconstructed in multiple planes from a single data set, obviating the need for separate coronal and axial acquisitions and thereby minimizing radiation exposure. When the area of interest involves scans through the orbital region, attempts should be made to minimize radiation dose to the lens. For contrast-enhanced studies, split-bolus technique may provide better lesion and vascular enhancement.

A. Patient Selection

When possible, it may be prudent, particularly in pediatric and young adult patients, to consider using magnetic resonance imaging (MRI) or ultrasound instead of CT to reduce radiation dose [68-73]. In patients with biopsy-proven advanced malignancies, positron emission tomography (PET)- CT should be considered for staging [74]. In all patients, the lowest possible exposure factors that produce images of diagnostic quality should be chosen. This is particularly true in pediatric patients. Whenever possible, multiplanar reconstruction should be used to avoid repeated direct scans.

B. Neck CT
- Acquisition: The patient should lie on the table in the supine position with the neck slightly extended. The study should be performed with the patient breathing quietly. Initial imaging should be performed with the head tilted and/or a gantry angled to avoid streak artifact over the area of interest. If dental artifacts compromise diagnostic evaluation, additional imaging with different gantry angles and/or head tilt may be necessary. Most indications for soft-tissue neck CT can be evaluated with a scanned volume from the skull base to the top of the aortic arch. For studies specifically performed to evaluate for vocal cord palsy, the inferior extent of the CT examination should extend to the aortopulmonary window. Very thin sections with multiplanar reconstructions limited to the larynx may be helpful for evaluating patients with vocal cord neoplasms, with axial sections (or axial reformats) parallel to the vocal cords or hyoid bone.
- Reformation: All studies should be reconstructed in soft-tissue algorithm in axial, coronal, and sagittal planes. Additional reconstruction with a suitable reconstruction kernel or technique to improve bone and cartilage depiction may be obtained in at least 1 plane. Display slice thickness should not exceed 3 mm.
- Intravenous (IV) contrast versus noncontrast: IV contrast is usually recommended in patients without contraindications. For selected indications, a noncontrast examination may be obtained focused to the area of specific interest, such as concern for a foreign body, trauma, or for salivary stones.
- Special considerations: For parathyroid adenoma localization, multiple phases are often acquired, including noncontrast and postcontrast studies (often arterial and venous phases). For advanced thyroid cancer, IV contrast is preferred as it provides critical information regarding both primary and regional staging for surgical planning. Prolonged delay of radioactive iodine therapy of longer than 1 month following iodinated contrast administration is likely unnecessary and is not recommended by the American Thyroid Association (ATA) [75-77].

C. Sinus CT
- Acquisition: With a multidetector CT, axial images are most commonly performed parallel to the hard palate. The scanned volume should be from above the top of the frontal sinus and continue inferiorly through the maxillary teeth.
- Reformations: Routine axial, sagittal, and/or coronal reformations should be reconstructed. Coronal reformations are performed perpendicular to the plane of the hard palate from the nasal vestibule to the sella. Sagittal reformations are performed perpendicular to the plane of the hard palate through the maxillary sinuses.
- IV contrast versus noncontrast: Contrast is not recommended for evaluating facial trauma or for routine evaluation of patients with uncomplicated sinusitis. IV contrast should be used to evaluate neoplasms. IV contrast is also indicated to evaluate patients with complicated sinusitis as indicated by proptosis, periorbital or facial swelling, or other signs suspicious of intracranial or orbital extension.
- Special considerations: Considerations should be given to specific acquisition parameters required for image use in surgical navigation.

D. Orbital CT
- Acquisition: With multidetector CT, a standard examination should consist of image acquisition in the axial plane, with coronal and sagittal reformations. The patient should be positioned and the gantry angle should be adjusted to optimize image acquisition. The scanned volume should encompass the bony orbit.
- Reformations: All studies should be reconstructed in axial, coronal, and sagittal planes. Studies should be reconstructed in soft-tissue and bone algorithms. The display slice thickness should not exceed 3 mm. When evaluating for small foreign bodies, the display slice thickness should not exceed 1.5 mm.
- IV contrast versus noncontrast: IV contrast is indicated when evaluating neoplasms, infectious/inflammatory disorders, and vascular lesions. Noncontrast imaging may be performed in selected clinical situations, such as thyroid eye disease, foreign body, and trauma.
- Special considerations: Prone, head back, or coronal images with or without Valsalva maneuvers may elucidate some vascular lesions.

E. Temporal Bone
- Acquisition: With a multidetector CT, a standard examination should consist of image acquisition in the axial plane, with coronal and optional oblique reformations. The patient should be placed in the supine position. For scanners in which the gantry can be angled, the gantry angle should be parallel to the infraorbital-meatal line. If the gantry cannot be angled, the patient should be positioned appropriately for the scanner. The scanned volume should be from above the superior-most mastoid air cells above the bony portion of the external auditory canal (EAC) through the mastoid tip inferiorly.
- Reformations: All studies should be reconstructed in bone algorithm. The display slice thickness should not exceed 1.0 mm. The right and left sides should be reconstructed in axial as well as coronal and/or oblique planes, using magnified small, reconstructed FOVs. The axial images are optimally reformatted either parallel to the plane of the hard palate or parallel to the lateral semicircular canals and coronal images perpendicular to the plane of the hard palate. Reconstruction of the posterior fossa using soft-tissue algorithm with a wide FOV is also recommended. Additional reformations of a high-quality multidetector acquisition in the short axis (or Poschl parallel to the plane of the superior semicircular canals) and long axis (or Stenvers perpendicular to the plane of the superior semicircular canals) planes may provide additional useful information, particularly in the evaluation of superior semicircular canal dehiscence.IV contrast versus noncontrast: Temporal bone CT is usually performed without contrast for conductive hearing loss. IV contrast is indicated when evaluating patients with suspected acute coalescent mastoiditis in order to look for associated complications, including venous thrombosis, and epidural and subperiosteal abscess. IV contrast is also indicated for neoplasms or suspected vascular pathology.

V. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Parameter for Communication of Diagnostic Imaging Findings [78].

For specific issues regarding CT quality control, see the ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography (CT) and the ACR-AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment [61,79].

VI. EQUIPMENT SPECIFICATIONS

A. Performance Guidelines
For patient imaging, the CT scanner should meet or exceed the following specifications:
1. Gantry rotation period: minimum, not > 1 second
2. Display slice thickness: minimum, not > 1.5 mm
3. Limiting spatial resolution: must be measured to verify that it meets the unit manufacturer's

specifications.

    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, and be consistent with local regulatory requirements. The equipment, medications, and other emergency support must also be appropriate for the range of ages and sizes in the patient population.

Equipment monitoring should be in accordance with the [ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment](#) [79].

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, non-physician radiology providers**,** 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 who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

Nationally developed guidelines, such as the [ACR's Appropriateness Criteria](#)®, should be used to help choose the most appropriate imaging procedures to prevent unnecessary radiation exposure.

Facilities should have and adhere to policies and procedures that require ionizing radiation examination protocols (radiography, fluoroscopy, interventional radiology, CT) to vary according to diagnostic requirements and patient body habitus to optimize the relationship between appropriate radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used, except when inappropriate for a specific exam. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org). 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 periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, 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; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

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 *ACR Position Statement on Quality Control & Improvement, Safety, Infection Control, and Patient Education* on the ACR website (https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Quality-Control-and-Improvement).

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 (https://www.acr.org/Clinical-

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

ACR   ASNR

Ashley H. Aiken, MD, Chair   Kavita K. Erickson, MD

Paul M. Bunch, MD   David A. Joyner, MD

Tabassum A. Kennedy, MD   Ryan K. Lee, MBA, MD

Richard B. Towbin, MD, FACR   David S. Liebeskind, MD, FAAN, FAHA, FANA, FSVIN, FWSO

SPR

Mai-Lan Ho, MD

Eman Mahdi, MD

Caroline Robson, MBChB

Committee on Practice Parameters – Neuroradiology

(ACR Committee responsible for sponsoring the draft through the process)

Steven W. Hetts, MD, Chair   Masis Isikbay, MD, BS

Sameer A. Ansari, MD, PhD   John E. Jordan, MD, MPP, FACR

Kristine A. Blackham, MD   Lubdha M. Shah, MD

Gerald Drocton, MD   Raymond K. Tu, MD, FACR

Kavita K. Erickson, MD   Max Wintermark, MD

REFERENCES

1. Amichetti M, Zurlo A, Cristoforetti L, Valdagni R. Prognostic significance of cervical lymph nodes density evaluated by contrasted computer tomography in head and neck squamous cell carcinoma treated with hyperthermia and radiotherapy. Int J Hyperthermia 2000;16:539-47.
2. Ash L, Teknos TN, Gandhi D, Patel S, Mukherji SK. Head and neck squamous cell carcinoma: CT perfusion can help noninvasively predict intratumoral microvessel density. Radiology 2009;251:422-8.
3. Bisdas S, Baghi M, Wagenblast J, et al. Tracer kinetics analysis of dynamic contrast-enhanced CT and MR data in patients with squamous cell carcinoma of the upper aerodigestive tract: comparison of the results. Clin Physiol Funct Imaging 2009;29:339-46.
4. Bisdas S, Rumboldt Z, Wagenblast J, et al. Response and progression-free survival in oropharynx squamous cell carcinoma assessed by pretreatment perfusion CT: comparison with tumor volume measurements. AJNR Am J Neuroradiol 2009;30:793-9.

5. Bisdas S, Surlan-Popovic K, Didanovic V, Vogl TJ. Functional CT of squamous cell carcinoma in the head and neck: repeatability of tumor and muscle quantitative measurements, inter- and intra-observer agreement. Eur Radiol 2008;18:2241-50.
6. Chen AY, Vilaseca I, Hudgins PA, Schuster D, Halkar R. PET-CT vs contrast-enhanced CT: what is the role for each after chemoradiation for advanced oropharyngeal cancer? Head Neck 2006;28:487-95.
7. Chen TW, Yang ZG, Li Y, Li ZL, Yao J, Sun JY. Quantitative assessment of first-pass perfusion of oesophageal squamous cell carcinoma using 64-section MDCT: initial observation. Clin Radiol 2009;64:38-45.
8. Commowick O, Gregoire V, Malandain G. Atlas-based delineation of lymph node levels in head and neck computed tomography images. Radiother Oncol 2008;87:281-9.
9. Desai S, Teh BS, Hinojosa J, Bell BC, Paulino AC, Butler EB. Standardization of head and neck contouring using the acanthiomeatal line. Med Dosim 2009;34:225-7.
10. Groell R, Doerfler O, Schaffler GJ, Habermann W. Contrast-enhanced helical CT of the head and neck: improved conspicuity of squamous cell carcinoma on delayed scans. AJR Am J Roentgenol 2001;176:1571-5.
11. Hamilton S, Venkatesan V, Matthews TW, Lewis C, Assis L. Computed tomographic volumetric analysis as a predictor of local control in laryngeal cancers treated with conventional radiotherapy. J Otolaryngol 2004;33:289-94.
12. Henrot P, Blum A, Toussaint B, Troufleau P, Stines J, Roland J. Dynamic maneuvers in local staging of head and neck malignancies with current imaging techniques: principles and clinical applications. Radiographics 2003;23:1201-13.
13. Je BK, Kim MJ, Kim SB, Park DW, Kim TK, Lee NJ. Detailed nodal features of cervical tuberculous lymphadenitis on serial neck computed tomography before and after chemotherapy: focus on the relation between clinical outcomes and computed tomography features. J Comput Assist Tomogr 2005;29:889-94.
14. Kane AG, Reilly KC, Murphy TF. Swimmer's CT: improved imaging of the lower neck and thoracic inlet. AJNR Am J Neuroradiol 2004;25:859-62.
15. Katsura K, Hayashi T. Non-neoplastic process after neck dissection demonstrated on enhanced CT in patients with head and neck cancer. Dentomaxillofac Radiol 2005;34:297-303.
16. Keberle M, Tschammler A, Hahn D. Single-bolus technique for spiral CT of laryngopharyngeal squamous cell carcinoma: comparison of different contrast material volumes, flow rates, and start delays. Radiology 2002;224:171-6.
17. Ketelsen D, Werner MK, Thomas C, et al. Image quality analysis to reduce dental artifacts in head and neck imaging with dual-source computed tomography. Rofo 2009;181:54-9.
18. Masaryk T, Kolonick R, Painter T, Weinreb DB. The economic and clinical benefits of portable head/neck CT imaging in the intensive care unit. Radiol Manage 2008;30:50-4.
19. Mukherji SK, Toledano AY, Beldon C, et al. Interobserver reliability of computed tomography-derived primary tumor volume measurement in patients with supraglottic carcinoma. Cancer 2005;103:2616-22.
20. Namasivayam S, Kalra MK, Pottala KM, Waldrop SM, Hudgins PA. Optimization of Z-axis automatic exposure control for multidetector row CT evaluation of neck and comparison with fixed tube current technique for image quality and radiation dose. AJNR Am J Neuroradiol 2006;27:2221-5.
21. Nix PA, Coatesworth AP. Carotid artery invasion by squamous cell carcinoma of the upper aerodigestive tract: the predictive value of CT imaging. Int J Clin Pract 2003;57:628-30.
22. Petralia G, Preda L, Raimondi S, et al. Intra- and interobserver agreement and impact of arterial input selection in perfusion CT measurements performed in squamous cell carcinoma of the upper aerodigestive tract. AJNR Am J Neuroradiol 2009;30:1107-15.
23. Pfau PR, Perlman SB, Stanko P, et al. The role and clinical value of EUS in a multimodality esophageal carcinoma staging program with CT and positron emission tomography. Gastrointest Endosc 2007;65:377-84.
24. Preda L, Lovati E, Chiesa F, et al. Measurement by multidetector CT scan of the volume of hypopharyngeal and laryngeal tumours: accuracy and reproducibility. Eur Radiol 2007;17:2096-102.
25. Ryu CW, Kim JK, Kim SJ, et al. Head and neck vascular lesions: characterization of the flow pattern by the use of three-phase CT. Korean J Radiol 2009;10:323-32.
26. Scaglione M, Pezzullo MG, Pinto A, Sica G, Bocchini G, Rotondo A. Usefulness of multidetector row computed tomography in the assessment of the pathways of spreading of neck infections to the mediastinum. Semin Ultrasound CT MR 2009;30:221-30.
27. Schreyer AG, Scheibl K, Zorger N, et al. Detection rate and efficiency of lymph node assessment with axial

and coronal image reading based on 16 row multislice CT of the neck. Rofo 2005;177:1430-5.

28. Sliker CW, Shanmuganathan K, Mirvis SE. Diagnosis of blunt cerebrovascular injuries with 16-MDCT: accuracy of whole-body MDCT compared with neck MDCT angiography. AJR Am J Roentgenol 2008;190:790-9.

29. Sonmez A, Ozturk N, Ersoy B, Bayramicli M, Celebiler O, Numanoglu A. Computed tomography in the management of cervical lymph node pathology. J Plast Reconstr Aesthet Surg 2008;61:61-4.

30. Sumi M, Kimura Y, Sumi T, Nakamura T. Diagnostic performance of MRI relative to CT for metastatic nodes of head and neck squamous cell carcinomas. J Magn Reson Imaging 2007;26:1626-33.

31. Thurmuller P, Kesting MR, Holzle F, Retzgen H, Wolff KD. Volume-rendered three-dimensional spiral computed tomographic angiography as a planning tool for microsurgical reconstruction in patients who have had operations or radiotherapy for oropharyngeal cancer. Br J Oral Maxillofac Surg 2007;45:543-7.

32. Wear VV, Allred JW, Mi D, Strother MK. Evaluating "eee" phonation in multidetector CT of the neck. AJNR Am J Neuroradiol 2009;30:1102-6.

33. Weidemann J, Stamm G, Galanski M, Keberle M. Comparison of the image quality of various fixed and dose modulated protocols for soft tissue neck CT on a GE Lightspeed scanner. Eur J Radiol 2009;69:473-7.

34. Wiener E, Pautke C, Link TM, Neff A, Kolk A. Comparison of 16-slice MSCT and MRI in the assessment of squamous cell carcinoma of the oral cavity. Eur J Radiol 2006;58:113-8.

35. Wippold FJ, 2nd. Head and neck imaging: the role of CT and MRI. J Magn Reson Imaging 2007;25:453-65.

36. Yoon DY, Hwang HS, Chang SK, et al. CT, MR, US,18F-FDG PET/CT, and their combined use for the assessment of cervical lymph node metastases in squamous cell carcinoma of the head and neck. Eur Radiol 2009;19:634-42.

37. Zima A, Carlos R, Gandhi D, Case I, Teknos T, Mukherji SK. Can pretreatment CT perfusion predict response of advanced squamous cell carcinoma of the upper aerodigestive tract treated with induction chemotherapy? AJNR Am J Neuroradiol 2007;28:328-34.

38. Tessler FN, Middleton WD, Grant EG, et al. ACR Thyroid Imaging, Reporting and Data System (TI-RADS): White Paper of the ACR TI-RADS Committee. J Am Coll Radiol 2017;14:587-95.

39. Basu S, Georgalas C, Kumar BN, Desai S. Correlation between symptoms and radiological findings in patients with chronic rhinosinusitis: an evaluation study using the Sinonasal Assessment Questionnaire and Lund-Mackay grading system. Eur Arch Otorhinolaryngol 2005;262:751-4.

40. Batra PS, Citardi MJ, Gallivan RP, Roh HJ, Lanza DC. Software-enabled CT analysis of optic nerve position and paranasal sinus pneumatization patterns. Otolaryngol Head Neck Surg 2004;131:940-5.

41. Baumann I, Koitschev A, Dammann F. Preoperative imaging of chronic sinusitis by multislice computed tomography. Eur Arch Otorhinolaryngol 2004;261:497-501.

42. Bisdas S, Verink M, Burmeister HP, Stieve M, Becker H. Three-dimensional visualization of the nasal cavity and paranasal sinuses. Clinical results of a standardized approach using multislice helical computed tomography. J Comput Assist Tomogr 2004;28:661-9.

43. Brem MH, Zamani AA, Riva R, et al. Multidetector CT of the paranasal sinus: potential for radiation dose reduction. Radiology 2007;243:847-52.

44. Cagici CA, Yilmazer C, Hurcan C, Ozer C, Ozer F. Appropriate interslice gap for screening coronal paranasal sinus tomography for mucosal thickening. Eur Arch Otorhinolaryngol 2009;266:519-25.

45. Gumus C, Yildirim A. Radiological correlation between pneumatization of frontal sinus and height of fovea ethmoidalis. Am J Rhinol 2007;21:626-8.

46. Hojreh A, Czerny C, Kainberger F. Dose classification scheme for computed tomography of the paranasal sinuses. Eur J Radiol 2005;56:31-7.

47. Mehle ME, Kremer PS. Sinus CT scan findings in "sinus headache" migraineurs. Headache 2008;48:67-71.

48. Nemec SF, Peloschek P, Koelblinger C, Mehrain S, Krestan CR, Czerny C. Sinonasal imaging after Caldwell-Luc surgery: MDCT findings of an abandoned procedure in times of functional endoscopic sinus surgery. Eur J Radiol 2009;70:31-4.

49. Tack D, Widelec J, De Maertelaer V, Bailly JM, Delcour C, Gevenois PA. Comparison between low-dose and standard-dose multidetector CT in patients with suspected chronic sinusitis. AJR Am J Roentgenol 2003;181:939-44.

50. Tingelhoff K, Moral AI, Kunkel ME, et al. Comparison between manual and semi-automatic segmentation of nasal cavity and paranasal sinuses from CT images. Conf Proc IEEE Eng Med Biol Soc 2007;2007:5505-8.

51. Triulzi F, Zirpoli S. Imaging techniques in the diagnosis and management of rhinosinusitis in children. Pediatr

Allergy Immunol 2007;18 Suppl 18:46-9.

52. Zammit-Maempel I, Chadwick CL, Willis SP. Radiation dose to the lens of eye and thyroid gland in paranasal sinus multislice CT. Br J Radiol 2003;76:418-20.

53. Asbury CC, Castillo M, Mukherji SK. Review of computed tomographic imaging in acute orbital trauma. Emergency Radiology 1995;2:367-75.

54. Castillo M, Mukherji SK, Wagle NS. Imaging of the pediatric orbit. Neuroimaging Clin N Am 2000;10:95-116, viii.

55. Gerstle RJ, Mukherji SK, Wagle N, Stone T. Atypical CT findings of orbital cavernous hemangioma. AJR Am J Roentgenol 1999;172:249-50.

56. Mulkens TH, Broers C, Fieuws S, Termote JL, Bellnick P. Comparison of effective doses for low-dose MDCT and radiographic examination of sinuses in children. AJR Am J Roentgenol 2005;184:1611-8.

57. Dutton JJ, Fowler AM, O'Malley BB, Mukherji SK. Cancer of the Orbit: Surgical Management: Part B Radiologic Imaging Concerns. In: Harrison LB, Session RB, Hong WK, et al., ed. *Head and Neck Cancer: A Multidisciplinary Approach*. Third ed. Philadelphia, Pa: Lippincott Williams & Wilkins; 2009:808-14.

58. Mukherji SK, Mancuso AA, Kotzur IM, et al. CT of the temporal bone: findings after mastoidectomy, ossicular reconstruction, and cochlear implantation. AJR Am J Roentgenol 1994;163:1467-71.

59. Swartz JD, Harnsberger HR, Mukherji SK. The temporal bone. Contemporary diagnostic dilemmas. Radiol Clin North Am 1998;36:819-53, vi.

60. American College of Radiology. ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Pregnant-Pts.pdf?la=en. Accessed January 8, 2020.

61. American College of Radiology. ACR practice parameter for performing and interpreting diagnostic computed tomography (CT). Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CT-Perf-Interpret.pdf?la=en. Accessed January 8, 2020.

62. Purcell YM, Kavanagh RG, Cahalane AM, Carroll AG, Khoo SG, Killeen RP. The Diagnostic Accuracy of Contrast-Enhanced CT of the Neck for the Investigation of Sialolithiasis. AJNR Am J Neuroradiol 2017;38:2161-66.

63. Forghani R, Kelly H, Yu E, et al. Low-Energy Virtual Monochromatic Dual-Energy Computed Tomography Images for the Evaluation of Head and Neck Squamous Cell Carcinoma: A Study of Tumor Visibility Compared With Single-Energy Computed Tomography and User Acceptance. J Comput Assist Tomogr 2017;41:565-71.

64. Kuno H, Onaya H, Iwata R, et al. Evaluation of cartilage invasion by laryngeal and hypopharyngeal squamous cell carcinoma with dual-energy CT. Radiology 2012;265:488-96.

65. Forghani R, Levental M, Gupta R, Lam S, Dadfar N, Curtin HD. Different spectral hounsfield unit curve and high-energy virtual monochromatic image characteristics of squamous cell carcinoma compared with nonossified thyroid cartilage. AJNR Am J Neuroradiol 2015;36:1194-200.

66. De Crop A, Casselman J, Van Hoof T, et al. Analysis of metal artifact reduction tools for dental hardware in CT scans of the oral cavity: kVp, iterative reconstruction, dual-energy CT, metal artifact reduction software: does it make a difference? Neuroradiology 2015;57:841-9.

67. Bongers MN, Schabel C, Thomas C, et al. Comparison and Combination of Dual-Energy- and Iterative-Based Metal Artefact Reduction on Hip Prosthesis and Dental Implants. PLoS One 2015;10:e0143584.

68. Brenner D, Elliston C, Hall E, Berdon W. Estimated risks of radiation-induced fatal cancer from pediatric CT. AJR Am J Roentgenol 2001;176:289-96.

69. Brenner DJ, Doll R, Goodhead DT, et al. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. Proc Natl Acad Sci U S A 2003;100:13761-6.

70. Brody AS, Frush DP, Huda W, Brent RL. Radiation risk to children from computed tomography. Pediatrics 2007;120:677-82.

71. Frush DP, Donnelly LF, Rosen NS. Computed tomography and radiation risks: what pediatric health care providers should know. Pediatrics 2003;112:951-7.

72. Goske MJ, Applegate KE, Boylan J, et al. The 'Image Gently' campaign: increasing CT radiation dose awareness through a national education and awareness program. Pediatr Radiol 2008;38:265-9.

73. Huda W, Vance A. Patient radiation doses from adult and pediatric CT. AJR Am J Roentgenol 2007;188:540-6.

74. Branstetter BFt, Blodgett TM, Zimmer LA, et al. Head and neck malignancy: is PET/CT more accurate than

Revised 2001 (Resolution 35). Radiology 2005;235:580-6.

75. Mishra A, Pradhan PK, Gambhir S, Sabaretnam M, Gupta A, Babu S. Preoperative contrast-enhanced computerized tomography should not delay radioiodine ablation in differentiated thyroid carcinoma patients. J Surg Res 2015;193:731-7.

76. Sohn SY, Choi JH, Kim NK, et al. The impact of iodinated contrast agent administered during preoperative computed tomography scan on body iodine pool in patients with differentiated thyroid cancer preparing for radioactive iodine treatment. Thyroid 2014;24:872-7.

77. Haugen BR, Alexander EK, Bible KC, et al. 2015 American Thyroid Association Management Guidelines for Adult Patients with Thyroid Nodules and Differentiated Thyroid Cancer: The American Thyroid Association Guidelines Task Force on Thyroid Nodules and Differentiated Thyroid Cancer. Thyroid 2016;26:1-133.

78. American College of Radiology. ACR practice parameter for communication of diagnostic imaging findings. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CommunicationDiag.pdf?la=en. Accessed January 8, 2020.

79. American College of Radiology. ACR–AAPM technical standard for diagnostic medical physics performance monitoring of computed tomography (CT) equipment. Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CT-Equip.pdf?la=en. Accessed January 8, 2020.

80. Society for Pediatric Radiology. Image Gently Web Site. Available at: http://imagegently.org/. Accessed June 18, 2015.

CHRONOLOGY

*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.

Development Chronology for This Practice Parameter

2001 (Resolution 9)

Revised 2006 (Resolution 12, 17, 35)

Amended 2009 (Resolution 11)

Revised 2011 (Resolution 33)

Amended 2012 (Resolution 8-title)

Amended 2014 (Resolution 39)

Revised 2016 (Resolution 14)

Revised 2021 (Resolution 5)

Amended 2023 (Resolution 2c, 2d)