# American College of Radiology
# ACR Appropriateness Criteria®

**Clinical Condition:** **Seizures and Epilepsy**

**Variant 1:** **Medically refractory epilepsy. Surgical candidate or surgical planning.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without IV contrast | 8 | | O |
| MRI head without and with IV contrast | 8 | | O |
| FDG-PET/CT head | 7 | This procedure may be helpful in preoperative planning. | ☢☢☢☢ |
| CT head with IV contrast | 6 | | ☢☢☢ |
| MRI functional (fMRI) head without IV contrast | 6 | This procedure may be helpful in preoperative planning. | O |
| MEG | 6 | This procedure may identify IOZ in nonlesional patients (normal MRI), can provide confirmatory localization information, and may guide placement of iEEG. It may substitute for invasive testing and may be useful when other tests are discordant. | O |
| Tc-99m HMPAO SPECT head ictal | 5 | This procedure may provide confirmatory localization information. | ☢☢☢☢ |
| CT head without IV contrast | 5 | | ☢☢☢ |
| CT head without and with IV contrast | 4 | | ☢☢☢ |
| **Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

**Variant 2:** **New-onset seizure. Unrelated to trauma. Alcohol or drug related.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with IV contrast | 8 | In the acute or emergency setting, CT may be the imaging study of choice. | O |
| MRI head without IV contrast | 7 | In the acute or emergency setting, CT may be the imaging study of choice. | O |
| CT head without IV contrast | 7 | In the acute or emergency setting, CT may be the imaging study of choice. | ☢☢☢ |
| CT head with IV contrast | 6 | In the acute or emergency setting, CT may be the imaging study of choice. | ☢☢☢ |
| CT head without and with IV contrast | 3 | | ☢☢☢ |
| MRI functional (fMRI) head without IV contrast | 2 | | O |
| Tc-99m HMPAO SPECT head ictal | 2 | | ☢☢☢☢ |
| FDG-PET/CT head | 2 | | ☢☢☢☢ |
| MEG | 2 | | O |
| **Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

**Clinical Condition:** **Seizures and Epilepsy**

**Variant 3:** **New-onset seizure. Unrelated to trauma. Age 18–40.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without IV contrast | 8 | In the acute or emergency setting, CT may be the imaging study of choice. | O |
| MRI head without and with IV contrast | 7 | In the acute or emergency setting, CT may be the imaging study of choice. | O |
| CT head without IV contrast | 7 | In the acute or emergency setting, CT may be the imaging study of choice. | ☢☢☢ |
| CT head with IV contrast | 6 | In the acute or emergency setting, CT may be the imaging study of choice. | ☢☢☢ |
| Tc-99m HMPAO SPECT head ictal | 4 | | ☢☢☢☢ |
| FDG-PET/CT head | 4 | | ☢☢☢☢ |
| CT head without and with IV contrast | 3 | | ☢☢☢ |
| MRI functional (fMRI) head without IV contrast | 2 | | O |
| MEG | 2 | | O |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Variant 4:** **New-onset seizure. Unrelated to trauma. Older than age 40.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with IV contrast | 8 | In the acute or emergency setting, CT may be the imaging study of choice. | O |
| MRI head without IV contrast | 7 | In the acute or emergency setting, CT may be the imaging study of choice. | O |
| CT head without IV contrast | 7 | In the acute or emergency setting, CT may be the imaging study of choice. | ☢☢☢ |
| CT head with IV contrast | 6 | In the acute or emergency setting, CT may be the imaging study of choice. | ☢☢☢ |
| CT head without and with IV contrast | 5 | | ☢☢☢ |
| Tc-99m HMPAO SPECT head ictal | 4 | | ☢☢☢☢ |
| FDG-PET/CT head | 4 | | ☢☢☢☢ |
| MRI functional (fMRI) head without IV contrast | 2 | | O |
| MEG | 2 | | O |
| **Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate** | | | ***Relative Radiation Level** |

**Clinical Condition:** **Seizures and Epilepsy**

**Variant 5:** **New-onset seizure. Unrelated to trauma. Focal neurological deficit.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without and with IV contrast | 8 | In the acute or emergency setting, CT may be the imaging study of choice. | O |
| MRI head without IV contrast | 8 | Consider this procedure if intravenous contrast is contraindicated. In the acute or emergency setting, CT may be the imaging study of choice. | O |
| CT head with IV contrast | 7 | In the acute or emergency setting, CT may be the imaging study of choice. | ☢☢☢ |
| CT head without IV contrast | 7 | In the acute or emergency setting, CT may be the imaging study of choice. | ☢☢☢ |
| CT head without and with IV contrast | 3 | | ☢☢☢ |
| Tc-99m HMPAO SPECT head ictal | 3 | | ☢☢☢☢ |
| FDG-PET/CT head | 3 | | ☢☢☢☢ |
| MRI functional (fMRI) head without IV contrast | 2 | | O |
| MEG | 2 | | O |
| **Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

**Variant 6:** **New-onset seizure. Post-traumatic, acute.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| CT head without IV contrast | 9 | | ☢☢☢ |
| MRI head without and with IV contrast | 8 | | O |
| MRI head without IV contrast | 7 | Consider this procedure if intravenous contrast is contraindicated. | O |
| CT head with IV contrast | 5 | | ☢☢☢ |
| CT head without and with IV contrast | 3 | | ☢☢☢ |
| Tc-99m HMPAO SPECT head ictal | 2 | | ☢☢☢☢ |
| FDG-PET/CT head | 2 | | ☢☢☢☢ |
| MRI functional (fMRI) head without IV contrast | 2 | | O |
| MEG | 2 | | O |
| **Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

**Clinical Condition:** **Seizures and Epilepsy**

**Variant 7:** **New-onset seizure. Post-traumatic. Subacute or chronic.**

| Radiologic Procedure | Rating | Comments | RRL* |
|---|---|---|---|
| MRI head without IV contrast | 8 | Consider this procedure if intravenous contrast is contraindicated. | O |
| MRI head without and with IV contrast | 8 | | O |
| CT head without IV contrast | 7 | | ☢☢☢ |
| CT head with IV contrast | 6 | | ☢☢☢ |
| FDG-PET/CT head | 5 | | ☢☢☢☢ |
| MRI functional (fMRI) head without IV contrast | 4 | | O |
| CT head without and with IV contrast | 3 | | ☢☢☢ |
| Tc-99m HMPAO SPECT head ictal | 2 | | ☢☢☢☢ |
| MEG | 2 | | O |
| **Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | | | *Relative Radiation Level |

# SEIZURES AND EPILEPSY

Expert Panel on Neurologic Imaging: Michael D. Luttrull, MD[1]; Rebecca S. Cornelius, MD[2]; Edgardo J. Angtuaco, MD[3]; Kevin L. Berger, MD[4]; Julie Bykowski, MD[5]; Kathryn Holloway MD[6]; Marcus M. Kessler, MD[7]; Claudia Kirsch, MD[8]; Charles T. McConnell, Jr, MD[9]; Laszlo L. Mechtler, MD[10]; Joshua M. Rosenow MD[11]; Christopher J. Roth, MD[12]; Vilaas S. Shetty, MD[13]; Konstantin Slavin MD[14]; Alan D. Waxman, MD[15]; Franz J. Wippold II, MD.[16]

## Summary of Literature Review

### Introduction/Background

A seizure is a finite event of altered cerebral function because of excessive and abnormal electrical discharges of the brain cells. Epilepsy is a chronic condition predisposing a person to recurrent seizures. Epilepsy is common, affecting approximately 2 million people in the United States at any one time with a world-wide age-adjusted incidence of 16–111/100,000 people per year [1,2]. It has been estimated that about 7%–8% of the population experiences at least one epileptic seizure during their lifetimes [3]. The basic mechanism of epileptic seizures has not been fully elucidated.

The classification of epileptic seizures by the International League Against Epilepsy was last revised in 2010 [4,5]. The classification is important because etiologic diagnosis, appropriate treatment, and accurate prognostication all depend on the correct identification of seizures and epilepsy. There are 2 main types of seizures: generalized and focal. The separation of "focal" from "generalized" seizures is a useful construct—even if this separation is not truly distinct. Focal seizures are those arising within networks of a single cerebral hemisphere and may remain localized or subsequently become more widely distributed. Generalized seizures rapidly affect both hemispheres as well as both sides of the body—even when caused by a "focal" lesion. Generalized seizures are further subdivided into tonic-clonic, absence, myclonic, clonic, tonic, and atonic. The older classification terms for focal seizures ("simple partial," "complex partial," and "partial") have been supplanted, and these distinctions have been removed [4]. Certain types of seizure disorders are likely to be associated with structural brain lesions, including tumors, infection, infarction, traumatic brain injury, vascular malformations, developmental abnormalities, and seizure-associated brain pathology [6,7]. Hence, knowledge of seizure types helps to determine whether neuroimaging is clinically indicated and what type of study is appropriate.

### Overview of Imaging Modalities

Imaging modalities used in the evaluation of seizures can be subdivided into those evaluating brain structure, metabolism, perfusion, and electrical activity. Magnetic resonance imaging (MRI) and computed tomography (CT) are the primary modalities used in the evaluation of structural lesions known to induce seizures [8]. Clinical positron emission tomography (PET) with fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) provides a measure of glucose uptake and thus a measure of metabolism. A seizure focus will typically manifest as a focus of hypometabolism on interictal (between episodes of seizure activity) PET examinations. Additional PET tracers have been developed targeting specific brain receptors affected during seizures, including α-[11C]methyl-L-tryptophan in tuberous sclerosis, which are promising advancements in the evaluation and management of epilepsy [9]. Both bolus MRI (MR perfusion) and single-photon emission computed tomography (SPECT) that uses perfusion agents such as 99mTc-HMPAO or 99mTc-Neurolite, provide an assessment of regional cerebral blood flow rather than brain metabolism. A seizure focus will typically be seen as an area of hypoperfusion on interictal examinations and will demonstrate increased activity on *ictal* examinations [7]. Only

[1]Principal Author, Ohio State University Hospital, Columbus, Ohio. [2]Panel Vice-chair, University of Cincinnati, Cincinnati, Ohio. [3]University of Arkansas for Medical Sciences, Little Rock, Arkansas. [4]Chesapeake Medical Imaging, Annapolis, Maryland. [5]UC San Diego Health Center, La Jolla, California. [6]MCVH-Virginia Commonwealth University, Richmond, Virginia, American Association of Neurological Surgeons/Congress of Neurological Surgeons. [7]University of Arkansas for Medical Sciences, Little Rock, Arkansas. [8]Ohio State University Hospital, Columbus, Ohio. [9]Good Samaritan Hospital, Cincinnati, Ohio. [10]Dent Neurologic Institute, Amherst, New York, American Academy of Neurology. [11]Northwestern Memorial Hospital, Chicago, Illinois, American Association of Neurological Surgeons/Congress of Neurological Surgeons. [12]Duke University Medical Center, Durham, North Carolina. [13]Saint Louis University Hospital, St. Louis, Missouri. [14]UIC Medical Center, Chicago, Illinois, American Association of Neurological Surgeons/Congress of Neurological Surgeons. [15]Cedars-Sinai Medical Center, Los Angeles, California, Society of Nuclear Medicine and Molecular Imaging. [16]Panel Chair, Mallinckrodt Institute of Radiology, Saint Louis, Missouri.



Reprint requests to: publications@acr.org

electroencephalogram (EEG) (using either scalp electrodes or intracranial electrodes [iEEG]) and magnetoenecephalography (MEG) directly measure the brain's electrical activity [10]. As such, they could or should be the gold standard for seizure localization. Functional MRI (fMRI) techniques include phosphorus and proton spectroscopy (MRS), MR perfusion, and blood-oxygen-level dependent (BOLD) activation. The widespread application of most of these techniques in clinical practice depends on the widespread availability of high-performance MR imagers capable of performing fast echo-planar pulse sequences (EPIs), as well as substantial data postprocessing capabilities.

MRS is a set of noninvasive techniques for *in vivo* chemical analysis of the brain, some of which can be performed on standard-performance clinical MR units. Widely available proton and phosphorus single-voxel techniques have consistently demonstrated metabolite changes in the epileptogenic region of the brain. For example, typical metabolite changes on proton spectroscopy include reduced N-acetylaspartate and elevated lactate at in the region of the seizure focus [11,12].

***Variant 1: Medically refractory epilepsy; surgical candidate or surgical planning.***

**Computed Tomography/Magnetic Resonance Imaging**

Although the imaging evaluation of epilepsy was greatly advanced by the clinical introduction of CT in the early 1970s [13,14] because of its superior soft-tissue contrast, multiplanar imaging capability, and lack of beam-hardening artifacts, virtually all the substrates of epilepsy are visualized with greater sensitivity and accuracy by MRI [15-20]. As a result, MRI has become the modality of choice for high-resolution structural imaging in epilepsy. Routine evaluation techniques of all clinically available scanner field strengths may be sufficient for determining mass lesions. However, optimized protocols for scans obtained on high-field (>1.5 T) scanners may be necessary for evaluating focal seizures ("partial complex epilepsy"). These patients require scrutiny of the hippocampus and temporal lobe for atrophy and subtle signal alteration as well as for detecting certain structural abnormalities such as cortical dysplasias, hamartomas, and other developmental abnormalities [12,16,21-24]. Anatomic imaging identifies a focal abnormality in up to 54% of patients with focal seizures excluding atrophy and nonspecific white-matter lesions [25]. Intravenous contrast can be a useful addition to the MR examination, particularly if there is a clinical suspicion of infection, tumor, inflammatory lesion, or vascular pathology [7]. MR volumetric and relaxometry techniques have been shown to increase the detection of mesial temporal sclerosis [21,26,27]. With the widespread clinical availability of high-performance MRI systems, a comprehensive MRI examination, with functional techniques providing additional information, adding corroborative information, and improving overall accuracy, may in the future be of even greater value in diagnosing epilepsy.

**Functional Studies**

Although the data provided by MRI are essential in the presurgical evaluation of patients with medically refractory epilepsy, structurally detectable abnormalities are absent in many patients. In these patients, functional studies provide useful information on the location of the seizure focus. Functional imaging techniques, including PET, SPECT, magnetic source imaging (MSI), and fMRI, have contributed to the presurgical evaluation of patients with epilepsy [11,12,23,28-34].

The utility of isolated interictal cerebral perfusion assessment in patients without anatomic imaging abnormality has been shown to be limited due to low sensitivity and its false-positive rate [35,36]. The relative utility of interictal FDG-PET, ictal SPECT, and MRI at detecting seizure foci based on EEG criteria was evaluated in a meta-analysis by Spencer in 1994. Ictal SPECT was 90% sensitive and 77% specific at detecting temporal lobe epilepsy (TLE) and was 81% sensitive and 93% specific at detecting extratemporal epilepsy. It was the most sensitive test at detecting seizure foci regardless of location. Interictal FDG-PET was found to be 84% sensitive and 86% specific at detecting TLE and 33% sensitive and 95% specific at detecting extratemporal epilepsy. By comparison, structural imaging using a variety of MR field strengths and techniques yielded a sensitivity of 55% and a specificity of 78% in TLE and 43% sensitivity and 95% specificity in extratemporal epilepsy [23].

The use of subtraction ictal SPECT coregistered on MRI and image-guided surgery datasets is proving to be more useful than interictal perfusion imaging alone [36]. A recent study comparing the performance of subtraction ictal SPECT and interictal PET at detecting seizure foci found on intracranial EEG monitoring demonstrated ictal/interictal subtraction imaging to be the more sensitive examination. However, both modalities revealed complementary information [37]. Injection of the blood flow agent within 90 seconds of seizure onset does, however, appear to be required to demonstrate the expected localized increase in cerebral perfusion on ictal SPECT [38]. The use of ictal perfusion techniques in epilepsy is therefore often limited to specialized centers

because of the technological and staffing challenge of injecting EEG-monitored patients within 90 seconds of seizure onset.

Out of the fMRI techniques available, BOLD imaging appears to be the most useful for preoperative planning. In a prospective study of 53 patients with seizure, fMRI results altered patient and family counseling in 58% of patients, prevented further studies including Wada tests in 63%, altered intraoperative mapping plans in 52%, changed surgical plans in 42%, prevented 2-stage surgery in 8%, and altered the extent of surgical resection in 7% due to identification of nearby eloquent areas of brain [39].

MRS or chemical shift imaging (CSI) allows simultaneous acquisition of spectra from all brain regions. The pictorial display of MRS information facilitates comparison of the epileptogenic zone with the remainder of the brain and provides localizing information. Studies suggest that both proton and phosphorus MRS may be useful adjunctive presurgical tests for localizing seizure foci in patients with partial epilepsy, particularly in difficult cases, potentially reducing the need for intracranial-depth electrode EEG recordings, and in those with extratemporal seizure foci [11,12,30,32,33]. However, CSI is not yet widely available in clinical practice, and more study is needed to clarify its use in clinical practice.

In terms of outcome, being "seizure free" is an appropriate metric. Both EEG and MEG offer significantly higher temporal resolution (ms), as compared with interictal PET, ictal SPECT, and fMRI, which are poor by comparison (sec-min). Recent improvements in MEG technology—with advanced electronics and 100–300 or more channels of whole-head magnetometers—now allow complete brain coverage and overlay of source information on magnetic source images (MSIs). Recent articles in the radiology literature describe both the techniques and the advantages of including MEG in the preoperative evaluation of patients with intractable or medically refractory seizures [10,40]. The MEG images are often superimposed on high-resolution MRIs. MEG is not a "frontline" tool for evaluation of epilepsy. A literature review supports some utility for MEG in the subset of patients who: a) are surgical candidates for resection; b) do not have a lesion identified on scalp EEG and MRI or have multiple potential seizure foci; or c) are candidates for invasive monitoring (iEEG).

MEG is thus complementary to EEG and may provide confirmatory information for the ictal onset zone (IOZ) localization for potential lesions seen on MRI. MEG provides better spatial resolution (2–3 mm) as compared to EEG (7–10 mm) [41]. MEG can also guide the placement of iEEG grids, and in certain patients it may help distinguish among multiple potential seizure foci.

The use and utility of MEG are growing but are by no means settled. Many of the strong advocates for MEG have become familiar with the technique from their own research and have made their own contributions to this literature [42-45]. It might well be emphasized that MEG has the most value in the hands of experienced users in epilepsy referral centers.

***Variants 2–7: New-onset seizures.***

**Computed Tomography/Magnetic Resonance Imaging**

New-onset seizures can be divided into those that are suspected to have an acute preceding structural or metabolic cause such as trauma, tumor, or infection (formerly called provoked or acute symptomatic seizures) and those lacking a suspected, acute triggering condition (formerly called unprovoked, cryptogenic, idiopathic, or remote symptomatic seizures). In both categories of new-onset seizures, structural imaging plays an important role in diagnosing treatable lesions and in determining whether or not antiepileptic drug therapy should be initiated [46,47]. In a review of 7 class II studies using either CT or MRI in the evaluation of new-onset, unprovoked seizures, significant abnormalities were found in an average of 10% patients that altered medical management [48]. Studies have found that patients with focal neurologic deficits, head trauma, focal onset of seizure, history of HIV or malignancy, children <6 months of age, and the elderly are at higher risk of having abnormalities on imaging or have findings on CT that significantly altered management in the emergent setting [46,47,49-53]. MRI is preferred over CT in the assessment of a first seizure due to its increased sensitivity at detecting intracranial abnormalities [47,54]. In 2007, an expert panel on the Quality Indicators for Epilepsy Treatment (QUIET) study identified a list of 24 evidence-based measures for the evaluation and treatment of patients with epilepsy. Evaluation of new-onset seizure was the first quality indicator listed by the panel, and orders for both EEG and neuroimaging with MRI or CT (MRI preferred) or, alternatively, a referral to a higher level of epilepsy specialty care were included among its elements [55]. In urgent and emergency room settings, CT is generally accepted as the imaging study of choice for patients presenting with new-onset seizure [46,47,49-53]. Addition of intravenous contrast to either an MRI or CT examination is useful in the assessment for underlying tumor, infection,

inflammatory lesion, or vascular pathology; its potential added value will depend on clinical history and patient demographics [7].

**Functional Studies**

Although the roles of functional imaging with interictal PET, ictal SPECT, fMRI, and MEG are scientifically established in the presurgical evaluation of patients with medically refractory epilepsy, their utility in the evaluation of patients with new-onset seizure appears limited. No articles concerning functional imaging techniques and their role in the clinical diagnosis, management, or outcomes of new-onset seizure patients were identified in the recent literature review. However, in certain circumstances, functional imaging techniques may provide additional information useful in establishing the diagnosis of acute epileptogenic lesions associated with focal neurologic deficits such as infarcts, intracranial abscess and infection, primary CNS neoplasm, metastasis, and lymphoma (see the ACR Appropriateness Criteria® "Focal Neurologic Deficit").

***Variant 2: New-onset seizure, unrelated to trauma. Alcohol or drug related.***

Patients presenting with a new-onset seizure that is suspected to be drug or alcohol related should undergo neuroimaging with either MRI or CT. CT is generally accepted as the test of choice to be performed in the emergency setting [47,49]. If imaging is deferred on an outpatient basis, MRI is preferred over CT due to its increased sensitivity at detecting intracranial abnormalities [47,54,55]. In a study of 259 patients presenting with a first, alcohol-related, generalized convulsive seizure, 6.2% were found to have intracranial lesions. Clinical management was changed based on the CT result in 3.9% of the patients, and there was no significant correlation between abnormal head CT results and level of consciousness or focal neurologic abnormalities on exam [50].

***Variant 3: New-onset seizure, unrelated to trauma. Age 18-40.***

Patients presenting with new-onset seizures between the ages of 18 and 40 who lack a history of preceding trauma should undergo neuroimaging with either MRI or CT (MRI preferred) [55]. CT may be more appropriate in the emergency setting [47,49]. Diagnoses of underlying abnormalities found on imaging in this age group can often be made on noncontrast MR examinations and include intracranial trauma and arteriovenous malformations. Tumors are less frequent [53]. However, a contrast-enhanced examination should still be performed if intracranial infection, tumor, inflammatory lesion, or vascular pathology are suspected [7].

***Variant 4: New-onset seizure, unrelated to trauma. Older than age 40.***

Patients presenting with new-onset seizures over age 40 who lack a history of trauma should undergo neuroimaging with either MRI or CT (MRI preferred) [55]. CT may be more appropriate in the emergency setting [47,49]. Patients in this age group have a higher association with abnormal findings on MRI, including an increased frequency of underlying stroke or tumor [51,53,56]. Therefore, contrast-enhanced examinations are more appropriate in this population.

***Variant 5: New-onset seizure, unrelated to trauma. Focal neurological deficit.***

Patients presenting with new-onset seizures associated with a focal neurological deficit and who lack a history of preceding trauma should undergo neuroimaging with either MRI or CT (MRI preferred) [55]. CT may be more appropriate in the emergency setting [47,49]. The presence of a focal neurological deficit in the setting of a new-onset seizure has been found to be associated with a higher risk of subsequent abnormalities on neuroimaging [46,51-53]. In a prospective study of 119 adult patients presenting to an urban emergency department with first seizure, a focal neurological defect was found to be 50% sensitive and 89% specific in the identification of patients with a focal lesion on CT (odds ratio 4.9 [95% confidence interval, 1.7–13.7]). Etiology of seizure for those with focal neurologic defects was primary neoplasm (25%), metastasis (25%), intracranial hemorrhage (20%), infarct (20%), and toxoplasmosis (10%) [51]. Functional imaging techniques may provide additional useful information in establishing the diagnosis (see the ACR Appropriateness Criteria® "Focal Neurologic Deficit").

***Variant 6: New-onset seizure. Post-traumatic, acute.***

The imaging test of choice for patients presenting with new-onset, post-traumatic seizures in the acute setting is a noncontrast head CT due to the high association of acute intracranial hemorrhage in this patient population. MRI is also useful in evaluating for acute traumatic brain injury (see the ACR Appropriateness Criteria® "Head Trauma"). In a series of 100 adult patients who presented with post-traumatic seizure within one week of minor closed head injury, 41% were found to have intracranial hemorrhage, and 7% underwent craniotomy for evacuation of hematoma associated with mass effect and midline shift [57]. Penetrating injuries, skull fractures, or

frontal sinus fractures may become complicated by significant intracranial infections [58]. Therefore, contrast-enhanced examinations may be useful in the appropriate clinical setting.

***Variant 7: New-onset seizure. Post-traumatic. Subacute or chronic.***

Patients who develop a new-onset seizure following nonacute head trauma (ie, greater than one week in the past) may be experiencing a "late-onset" post-traumatic seizure. MRI is the preferred imaging modality in the assessment of traumatic brain injury beyond the acute phase due to its higher sensitivity at detecting hemosiderin deposition from prior intracranial hemorrhage on T2 gradient or susceptibility-weighted sequences [59] (see the ACR Appropriateness Criteria® "Head Trauma"). CT may be more appropriate in the emergency setting [47,49]. Morphologic assessment of gliomesenchymal lesions on MRI as well as more advanced MRI applications such as diffusion tensor imaging may prove to be useful in predicting the development of late-onset post-traumatic epilepsy, although more research is needed [59,60].

**Summary**

- This document addresses several subsets of patients with seizures and epilepsy.
- MRI is the imaging test of choice for the evaluation of medically refractory epilepsy patients who are surgical candidates.
- Some medically refractory epilepsy patients may have more than one lesion and/or discordance between electrical findings on EEG and imaging localization. In these circumstances interictal FDG-PET, MEG, and ictal SPECT imaging may help define the most likely ictal-onset zone. fMRI may be most useful in surgical planning to avoid damage to critical structures.
- Patients presenting with new-onset seizures should undergo imaging with either MRI or CT, with MRI being the preferred modality. CT may be more appropriate in the emergency setting.
- CT is the imaging test of choice in the evaluation of patients presenting with seizures following acute trauma. MRI can be useful in the evaluation of post-traumatic seizures in both the acute and, particularly, the nonacute setting.
- Addition of intravenous contrast to either an MRI or CT examination is useful in the assessment for underlying tumor, infection, inflammatory lesion, or vascular pathology.

**Relative Radiation Level Information**

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

| Relative Radiation Level Designations | | |
|---|---|---|
| **Relative Radiation Level*** | **Adult Effective Dose Estimate Range** | **Pediatric Effective Dose Estimate Range** |
| O | 0 mSv | 0 mSv |
| ☢ | <0.1 mSv | <0.03 mSv |
| ☢☢ | 0.1-1 mSv | 0.03-0.3 mSv |
| ☢☢☢ | 1-10 mSv | 0.3-3 mSv |
| ☢☢☢☢ | 10-30 mSv | 3-10 mSv |
| ☢☢☢☢☢ | 30-100 mSv | 10-30 mSv |
| *RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies". | | |

**Supporting Documents**

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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