Seizures: Diagnostic Evaluation

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Objectives

- Recap of seizures
- Tests for acute seizures
- EEG
- Neuroimaging
- Other tests
Seizures and Epilepsy

- **Seizure**: A sudden stereotyped episode with change in motor activity, sensation, behavior, and/or consciousness
  - Due to an abnormal electrical discharge in the brain

- **Provoked seizure**: Seizure with an acute antecedent cause, such as CNS infection, trauma, metabolic abnormality and fever

- **Unprovoked seizure**: No immediate provoking factor

- Single seizure does not constitute a diagnosis of epilepsy

- Epilepsy is the condition of recurrent unprovoked seizures

Source: Joshi and Shellhaas 2014
Evaluation of a Child Presenting with a Seizure

• History:
  • Thorough description of event
  • Detailed medical history
• Establish that the event in question is most likely a seizure, and not a paroxysmal non-epileptic event (to be discussed in a separate session)
Acute Evaluation

• Routine Labs:
  • Common tests:
    • Glucose
    • Electrolytes
    • Serum Alcohol level
    • Toxicology drug screen
    • Anti-seizure medication levels (where applicable)

• Yield is low in the absence of clinical signs/symptoms
• Ordered on a case-by-case basis
Acute Evaluation: LP?

• After a first seizure, should a Lumbar Puncture be performed?
  • Lumbar puncture is not recommended routinely following a single unprovoked seizure
  • Lumbar puncture should be considered if:
    • Clinical suspicion of CNS infection
    • Young child (<6 months), and/or persistent altered mental status, or failure to return to baseline
  • Modest CSF pleocytosis can be seen after a seizure (complex febrile, afebrile unprovoked, status epilepticus)
ELECTROENCEPHALOGRAM (EEG)
History of the EEG

• Hans Berger
  • German physiologist and neuropsychiatrist
  • Invented and named the Electroencephalogram
  • Recorded the first EEG in humans (on a pediatric family member!); 1924
Clinical use of EEG: Indications

• After a new onset seizure
  • Optimal timing not clear
  • Usually ok to do as outpatient (urgent or emergent EEG should be considered for persistent mental status changes to rule out subclinical seizures)
• EEG within 24-48 hours after a seizure more likely to be abnormal.
  • Some abnormalities, like postictal slowing, may be transient and should be interpreted cautiously
Clinical use of EEG: Indications

- Can be useful in diagnosing seizure vs. non-seizure
- Caution: Normal EEG does not rule out seizure
  - Single outpatient EEG abnormal in 70%
- Sometimes EEGs can be abnormal in the absence of epilepsy (~3% or normal children can have spikes on EEG)
Use of EEG in Epilepsy

• With some conditions, the EEG is very reliable
  • Absence epilepsy
  • Juvenile Myoclonic epilepsy
  • Benign Rolandic epilepsy
  • Infantile spasms and other epileptic encephalopathies

• EEG is limited with seizures arising from deeper brain areas, even during a seizure
Conclusions

• EEG is an important test in evaluating patients with suspected seizures
• It is often valuable at the onset and offset of the seizure
• Limitations of the EEG must be recognized
• Results must be correlated with clinical history
References


Neuroimaging

- Emergent imaging
  - Indicated to detect serious abnormality with immediate treatment implications (e.g. hemorrhage) → head CT
  - Incidence of lesions requiring acute intervention in children presenting with a first seizure is ~2%

- Non-urgent imaging
  - To detect abnormalities that might affect prognosis (therefore treatment decisions) → brain MRI
  - MRI abnormalities are found in 10-20%
    - Encephalomalacia and cerebral dysgenesis

Source:
- O’Dell, Epilepsia 1997;38(S8):184.
MRI vs CT

**MRI**

- **Advantages**
  - Sensitivity and specificity
  - Multiplanar views
  - No radiation exposure

- **Drawbacks**
  - Long acquisition time
  - Enclosed area
  - Limited access to patient
  - Sedation

**CT**

- **Advantages**
  - Fast acquisition time
  - Useful in acute situations (head trauma, bleed, encephalitis)
  - Sensitive for calcifications

- **Drawbacks**
  - Limited sensitivity for small mass lesions
  - Radiation exposure 100-1000x that of chest x-ray
MRI is the Most Useful!

- The primary role of neuroimaging is to identify structural abnormalities that underlie seizure disorders.
  - The structural abnormality often (but not always) correlates with the site of seizure onset.
- MRI is highly superior to CT in sensitivity and specificity.
- MRI provides the most detailed information about brain structures.
- Abnormalities found in 80% of patients with refractory focal epilepsy and 20% of patients with single unprovoked seizures.
Barriers to Use of MRI

- **Absolute contraindications**
  - Cardiac pacemaker
  - Cochlear implants
  - Other internal metallic things

- **Special circumstances**
  - Programmable Ventriculoperitoneal (VP) shunts may need to be reprogrammed after the MRI
  - Vagus Nerve Stimulator (VNS) requires a special send-receive coil

- **Artifact**
  - Movement
  - Dental braces

- **Young children often require sedation for an MRI**
Who Should Get Neuroimaging?

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The Guideline

• Studies are not prospective and case-controlled, thus none are Class 1
• Studies before 1989 do not include current MRI technology with 1.5 Tesla
• Most published studies are directed toward evaluation of the first seizure, particularly looking to identify an acute symptomatic cause (encephalitis, trauma, hemorrhage, etc)
• Children more often have “idiopathic” epilepsy compared to adults, so rates of MRI abnormalities will be lower in children (not true for infants)
Utility of MRI

• Imaging is most often abnormal in children with localization-related (focal) or remote symptomatic epilepsy

• Nearly 50% of imaging studies in children with new onset focal seizures are abnormal
  • 15-20% will provide useful information on etiology and focus
  • 2-4% will alter immediate medical management

• Significant abnormalities are rarely found in the absence of focal seizure, abnormal exam, focal EEG abnormality

• Infants are more likely to have focal seizures, epileptic seizures from a remote symptomatic etiology, or metabolic disorders
  • Focal cortical dysplasias are more common in infant-onset seizures
Recommendations for Neuroimaging of Patients with Epilepsy

- The best available imaging should be done to
  - Identify underlying pathologies such as tumors, infections, vascular malformations, traumatic lesions, strokes, etc that merit specific treatment
  - Provide the best possible explanation to account for the child’s seizure(s)
Indications for Structural Neuroimaging

• Focal epilepsy (except for typical benign idiopathic partial epilepsy)
  • Characteristics of the seizure
  • Focal EEG abnormalities
  • Focal exam abnormalities
  • History or exam that suggest remote symptomatic cause
    • Extreme prematurity, head trauma, etc
• Abnormal neurologic examination, significant developmental delay, or regression
• Stigmata of neurocutaneous disorders
Indications for Structural Neuroimaging

- Children younger than 2 years
  - Except for those with simple febrile seizures
- Children with characteristics of a symptomatic generalized epilepsy syndrome
  - Infantile spasms
  - Lennox-Gastaut syndrome
Indications for Structural Neuroimaging

- Failure to control seizures
- Worsening seizures
- Changes in seizure manifestations
- Developmental regression
- New-onset seizures presenting with evidence for a medical emergency
  - Raised ICP, status epilepticus, etc.
The Ideal Practice

• In the non-acute situation, the ideal practice is to obtain brain MRI in all patients with epilepsy, except in patients with a definite electroclinical diagnosis of:
  • Idiopathic generalized epilepsy syndrome
    • Absence, juvenile myoclonic epilepsy
  • Benign childhood focal epilepsy syndromes
    • BECTS (Rolandic epilepsy)
Get the Best Imaging Possible to Identify the Etiology of Seizures!

• MRI is particularly indicated for:
  • Onset of seizures at any age with evidence of **focal** onset in the medical history or on EEG
  • Onset of **unclassified** or apparently generalized seizures in the first year of life or in adulthood
  • Evidence of a focal fixed deficit on neurologic exam
  • Difficulty in obtaining control of seizures with first-line anti-seizure medications
  • Loss of control of seizures with medication or a change in the seizure pattern that may imply a progressive underlying lesion
References


Other Tests

• Genetic tests
  • Usually considered in epileptic encephalopathis, infantile spasms
    • Karyotype
    • Chromosome Microsomal Analysis
    • Targeted Gene testing
    • Whole exome sequencing

• Metabolic testing
  • Specific blood tests
  • Lumbar Puncture for metabolic tests

• Ancillary testing
  • Ophthalmology
  • Rarely skin or muscle biopsies