INTERICTAL + ICTAL EEG IN ADULTS

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The following should provide and introduction and background information on the clinical use of routine, ambulatory, and video-EEG monitoring in adults. This will complement the slide presentation, which will predominantly focus on illustrative clinical cases and EEG samples.

Routine EEG Studies

Electroencephalography (EEG) remains an important tool in the diagnosis and management of epilepsy. When the clinical history and physical examination findings suggest the diagnosis of seizure, the presence of epileptiform abnormalities on scalp recorded EEG can add to diagnostic certainty and help to classify the epilepsy type and syndrome. It is rare in adults to capture a seizure during a routine outpatient EEG, however interictal epileptiform discharges are highly correlated with a tendency for clinical seizures. In persons with a known diagnosis of epilepsy the EEG can assist with ongoing management. For example, the EEG can aid in determination of seizure recurrence risk when considering if anti-epileptic medications can be discontinued, can help guide medication choice, and is part of the localization of the epileptogenic zone in persons being considered for epilepsy surgery.

Epileptiform discharges are present in the first routine EEG in only 25-50% of patients with epilepsy (Marsen C et al, 1970; Salinsky et al, 1997). Repeating the EEG can increase the detection of spike and sharp waves to as high as 80-90% of persons with epilepsy. The sensitivity of EEG may vary considerably depending on seizure frequency, epilepsy syndrome, and site of seizure onset. The diagnostic yield of the EEG is increased by recording sleep, and by serial studies. Activating procedures such as hyperventilation and photic stimulation are also routinely used, and can increase detection of epileptiform discharges, particularly for generalized epilepsy. Interictal epileptiform abnormalities on EEG are highly specific for a seizure diagnosis. The likelihood of finding epileptiform discharges in a healthy adult without epilepsy is less than 1% (Gregory R et al, 1993). Misinterpretation of EEG in which artifacts or normal cerebral electrical potentials are misread as epileptiform is not uncommon in general practice, and can lead to misdiagnosis (Benbadis and Tatum, 2003). It is always important to interpret the EEG findings in light of the clinical history. It is important to remember that a normal EEG does not rule out a clinical diagnosis of epilepsy.

When routine EEG is unrevealing and seizures remain a diagnostic concern, prolonged recording with an ambulatory EEG or inpatient long-term video EEG can be considered. These extended studies have a greater likelihood of detecting interictal abnormalities as well as capturing clinical events (e.g. ictal EEG).

Prolonged Scalp EEG studies: Ambulatory vs. Inpatient EEG monitoring

Prolonged electroencephalography (EEG) recordings utilizing ambulatory units or in inpatient settings with video-EEG can offer distinct advantages over routine EEG studies. A primary advantage is the potential to capture seizures/spells for diagnostic purposes, as task which is rarely possible during a routine EEG recording. The increased duration of recording may also increase the likelihood of capturing interictal epileptiform abnormalities. Prolonged EEG recordings are most commonly used to help determine the etiology of recurrent spells when the diagnosis remains uncertain after a comprehensive history and physical examination, routine EEG, and appropriate head imaging. These technologies can also be used to help classify epilepsy (focal vs. generalized) and quantify seizure frequency when not otherwise evident. For persons with medically intractable partial epilepsy, long-term video-EEG monitoring is a key component of the evaluation for epilepsy surgery.

Each technology has its own advantages and disadvantages. Ambulatory EEG units typically allow recording for hours to several days in the home/outpatient environment whereas inpatient video-EEG can be continued for many days. Depending on the ambulatory EEG unit used, the EEG may not be acquired continuously, but will record random samples, spike detected samples, and patient marked events. Many ambulatory units record EEG only or offer video on a limited basis if turned on by the patient or family member. Often greater physical activity is possible during an ambulatory recording than during video-EEG monitoring, which can be advantageous when spells are activity dependent. However, activity and inability to continuously monitor electrode connectivity mean that ambulatory EEG is more prone to artifact limiting the quality of the record and increasing the risk for misinterpretation. Prolonged inpatient video-EEG monitoring demands greater

resources and is thus more expensive, but importantly allows real time monitoring of the EEG data and the clinical state of the patient. Patients can be tested during their seizures/spells. Because persons undergoing prolonged video-EEG are closely watched, anticonvulsant drugs can be lowered to increase the likelihood of recording seizures, a step that would generally carry unacceptable risk during ambulatory EEG in unmonitored/outpatient settings.

Increasing the duration of EEG monitoring can also increase the likelihood of capturing interictal epileptiform discharges. In a study of subjects suspected to have epilepsy but with normal routine EEG, the likelihood of capturing interictal epileptiform discharges during ambulatory EEG was 33% versus 24% with a sleep-deprived EEG (Liporace J. et al, 1998). In the same series, seizures were recorded in 15% of ambulatory recordings but none during sleep-deprived EEG studies. A significant advantage of video-EEG is the likelihood of recording spells (via provocative measures such as medication reduction, or through longer duration of recording), rather than relying on an interictal recording alone. As such, the yield of inpatient prolonged video-EEG for diagnosis of undefined spells is greater than that of ambulatory recordings. In retrospective series from tertiary epilepsy centers, 75% of admissions for spell classification have a definitive diagnosis on discharge (Parnell K. et al., 1999; Benbadis SR et al., 2004).

Inpatient Video EEG-Monitoring

Common indications for admission to an epilepsy monitoring unit are spell classification and the presurgical evaluation of medically refractory epilepsy. In some instances, video-EEG may also be used to quantify seizure frequency, better classify seizure type or epilepsy syndrome, or to provide close monitoring during anti-epileptic medication adjustment in high risk situations. Prolonged video-EEG monitoring is also considered the gold standard for diagnosis of psychogenic nonepileptic spells. Although certain clinical and historical features may strongly suggest PNES, even experienced epileptologists have been shown to misdiagnose PNES as epileptic seizures as often as 20% prior to a confirmatory video-EEG evaluation (Alsaadi M. et al., 2004).

Selected References

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Salinsky M, Kanter R, Dasheiff RM. Effectiveness of multiple EEGs in supporting the diagnosis of epilepsy: an operational curve. Epilepsia 1987; 28:331.

Additional Resources

1) AAN guideline: Evaluating an apparent unprovoked first seizure in adults
    a. www.aan.com/guidlines/
2) International League Against Epilepsy guidelines:

    a. Minimum Requirements for the diagnosis of psychogenic nonepileptic seizures: a staged approach (2013)
    b. Guidelines for photic stimulation
    c. www. Ilae.org/visitors/centre/guidelines/
3) American Clinical Neurophysiology Society Guidelines
    a. See relevant sections on EEG, long-term monitoring, and EEG in critical care
    b. www.acns.org/practice/guidelines