Pearls & Oy-sters: Errors in EEG interpretations

What is misinterpreted besides temporal sharp transients?

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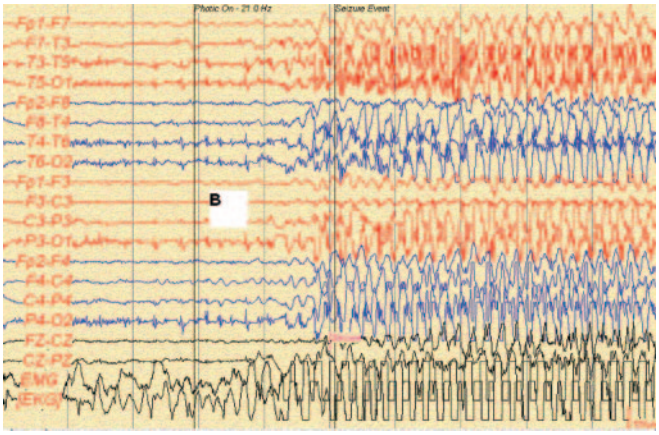
Figure 1 Alpha harmonic mistaken for an electrographic seizure

The misdiagnosis of epilepsy is common. Approximately 25%–30% of patients seen at epilepsy centers and previously diagnosed with epilepsy are found to have been misdiagnosed.[1,2] The overreading of benign EEG patterns often contributes to the misdiagnosis of epilepsy.[3,4] By far the most common overread patterns are temporal sharp transients, i.e., wicket spikes, or normal background fluctuations.[3,4] Occasionally, other types of errors are seen. Here we present 4 EEGs that had been overread as epileptiform due to less common errors. It is noteworthy that due to the more widespread availability of video EEG, 3 of the 4 are errors on ictal recordings, a relatively new phenomenon.

Figure 2 Ictal movement artifact misread as a photoconvulsive response



The first example (figure 1) shows an alpha harmonic rhythm (also known as slow alpha variant), a normal variant, mistaken for an electrographic seizure. Harmonics are caused by the summation of many frequencies that can add to or cancel each other, creating rhythmic waveforms that can be mistaken for seizures.

The second example (figure 2) shows an ictal movement artifact misread as an electrographic seizure ("photoconvulsive response"). This particular patient was shown to have psychogenic nonepileptic attacks, some induced by photic stimulation. The rhythmic movements pressing on the electrodes, like moving the head from side to side, can mimic a seizure pattern. This is where the simultaneous video can be helpful.

In the third example (figure 3), we show the importance of the appropriate settings. In this example, the high frequency filter was erroneously set at 15 Hz instead of 70 Hz (the EEG typically

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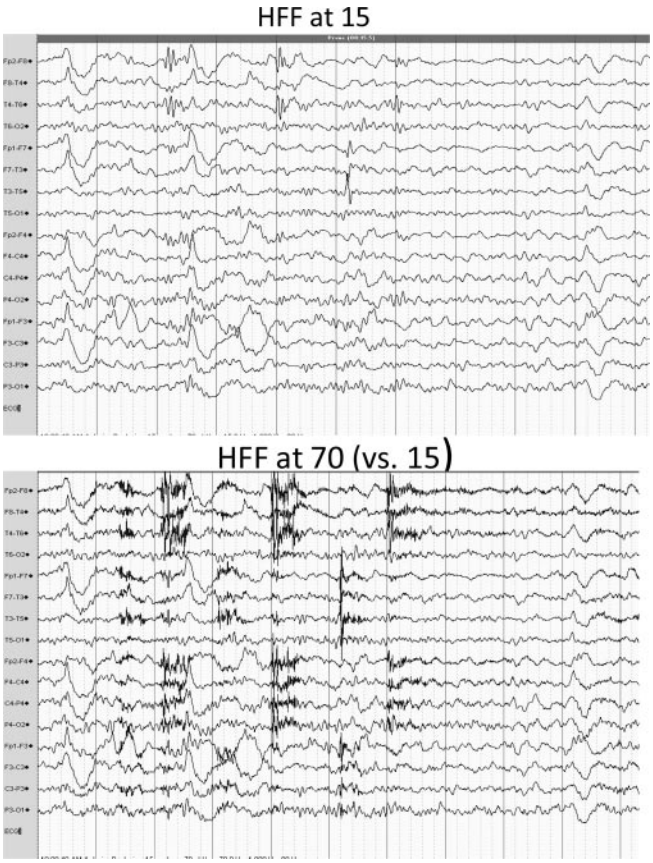
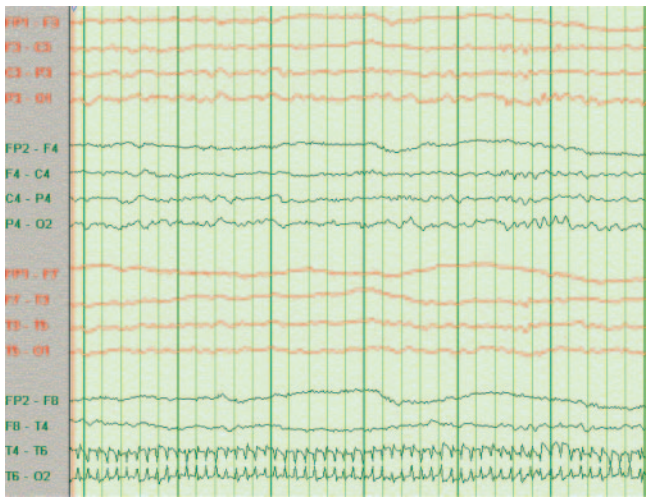
Figure 3 Filter error



The high frequency filter (HFF) was erroneously set at 15 Hz, giving EMG artifact the appearance of spikes. (Top) With HFF at 15 Hz; (bottom) with corrected HFF filter at 70 Hz.

does not have components above 70 Hz). This gave an EMG artifact the appearance of spike waves, misread as epileptiform. Filters can be helpful to clean up tracings, but one must be aware of how filter settings can distort waveforms.

Figure 4 Repetitive artifact at T6 mistaken for an electrographic seizure



The fourth example (figure 4) shows a repetitive electrode artifact at T6. This was mistaken for an electrographic seizure (characterized as a "clear electrographic seizure" in the original report). Electrode artifacts are very common in EEGs, especially "pop" artifacts that can superficially resemble spikes or sharp waves. When repetitive, they can mimic electrographic seizures. In general, activity that affects a single electrode should be considered artifact until proven otherwise. The artifact shown in this example can be confirmed on a referential montage, where only T6 is affected. This can also be confirmed by the presence of occasional pop artifact throughout the recording in the same electrode.

We should note that the EEGs are shown as we received them, using EEG software different from our own, and in these cases it was often not possible to change the display. This explains why the calibration (voltage scale and time base) is often not shown. This highlights the need for better compatibility among systems, and the importance of reviewing EEGs with a visible scale.

Reasons for overreading have been discussed elsewhere.[5] 1) The most fundamental reason is lack of experience. The less experience, the lower the threshold for "abnormality." 2) Being biased is also a culprit. Trying "too hard" to find abnormalities because the patient had a suspected seizure will result in overread EEGs. 3) Not applying strict criteria to make sharp transients epileptiform can be another reason. 4) Taking the EEG out of clinical context is another possible cause.

In making a diagnosis of epilepsy, the history is more important than the EEG, but unfortunately the EEG is often overemphasized, especially by those with minimal experience. The combination of vague nonspecific symptoms with an equivocal EEG abnormality is a common cause of inappropriate diagnosis of seizures.

Some possible solutions to the problem include 1) better EEG training during neurology residency; 2) defining special competency for neurologists who want to interpret EEGs. While there are currently competencies and board certifications (i.e., EEG and clinical neurophysiology boards), they are currently not required or mandatory to read EEGs in clinical practice[5]; 3) applying strict criteria to consider sharp waveforms epileptiform; 4) reading EEGs blind to the history, when possible; 5) "conservative" reading. Epileptologists agree that overreading is more harmful than underreading.[6] It is rare that a delay in the diagnosis of epilepsy will cause any harm. Conversely, misdiagnosing a patient with "seizures" because the EEG was misread has serious consequences.

DISCLOSURE

Dr. Hernandez-Frau reports no disclosures. Dr. Benbadis serves on scientific advisory boards for Ortho-McNeil-Janssen Pharmaceuticals, Inc., UCB, and

Lundbeck Inc.; serves on the editorial boards of *Epilepsy and Behavior*, *Epileptic Disorders*, and *eMedicine*; serves on Speakers' Bureaus for Cyberonics, Inc., GlaxoSmithKline, Lundbeck Inc., Pfizer Inc., SleepMed/DigiTrace, and UCB; and receives research support from UCB and Lundbeck, Inc. (formerly Ovation Pharmaceuticals).

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