Epileptic Disord 2011; 13 (2): 177-80

Rhythmic heart beat artefacts mimicking an ictal EEG pattern with abundant interictal epileptiform activity in both mother and child

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Received November 17, 2010; Accepted February 28, 2011

ABSTRACT – We present the EEG findings in a two-year-old girl with cryptogenic localisation-related epilepsy. The electroencephalogram showed fronto-temporal spike-wave discharges. In addition, the EEG repeatedly showed activity at different electrodes consisting of spikes with varying amplitude, rhythmicity and frequency, mimicking polyspikes. Both low- and high-amplitude spikes were generated from the same electrodes, however, only the low-amplitude spikes coincided with features of the child's electrocardiogram. Video monitoring showed the child's head resting on her mother's chest. This spike pattern was shown to be a heart beat artefact originating from the mother, as implied by the rhythmicity and the shift to other electrodes by moving the child's head, causing electrocardiogram artefacts on the posterior electrodes. This case study underscores the importance of routine use of simultaneous electroencephalogram and video monitoring. *[Published with video sequences]*

Key words: heart beat artefact, EEG artefact, electrocardiogram, interictal, ictal EEG pattern

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doi:10.1684/epd.2011.0431

We present an electroencephalogram (EEG) with intermittent rhythmic epileptiform discharges which simultaneously showed rhythmic electrocardiogram (ECG) artefacts that could be confused with an ictal pattern. One of the most common pitfalls of EEG interpretation is to mistakenly identify non-cerebral potentials as originating from the brain. ECG artefacts are easily recognized by their rhythmicity, regularity and coincidence with the ECG channel. Small artefacts reflect mainly the R wave, whereas larger artefacts are more difficult to differentiate when they do not coincide with the ECG, as in this case report.

Case study

A two-year-old girl with a history of frequent febrile seizures and developmental delay underwent an EEG. Her history was otherwise unremarkable. The family history was negative for epilepsy and febrile seizures. EEG monitoring with simultaneous ECG and video recording showed normal background activity and a normal cardiac sinus rhythm. The interictal EEG showed 3-Hertz (Hz) spike-wave discharges with regional spread involving the frontal and temporal lobes, bilaterally (*figure 1A*; *see video sequence*). No difference was seen in spike pattern between the left and right fronto-temporal areas. At times, this activity gradually increased in amplitude and rhythmicity. The activity ended with a short attenuation postictally. These intermittent rhythmic epileptiform discharges were not accompanied by overt clinical manifestations of a seizure.

As well as these epileptiform discharges, the EEG showed two periodic diphasic monomorphic spike patterns with a frequency of 14-16 Hz with different amplitudes; one with low amplitude and one with high amplitude. These patterns repeatedly appeared at the same electrodes and were not associated with clinical manifestations. The patterns were rhythmic, with a clear difference in frequency and rhythmicity between low- and high-amplitude spikes. This different rhythmicity mimicked the frequency of polyspikes.

The low-amplitude spikes occurred consistently with R waves in the ECG, contrary to the high-amplitude spikes. The child rested with the right side of her head on her mother's chest. By turning the child's head to the left, the spikes changed in amplitude and distribution with a maximum amplitude over the left occipital lobe and a downward deflection. Again, the low-amplitude spikes, and not the high-amplitude spikes, occurred consistently with the R waves in the ECG *(see video sequence)*.

After the child's head turned completely to the left, diphasic monomorphic spikes were seen in the left temporal lobe with a downward deflection in the source montage *(figure 1B)*. These spikes were rhythmic, with a clear difference in frequency and rhythmicity compared to the aforementioned spike patterns. Each first spike, unlike each second spike, occurred consistently with the R waves in the ECG. These elements of the graph mimicked the frequency of slow spike-wave discharges in the left midtemporal area.

The back of the child's head was resting on her mother's chest *(see video sequence)*. The rhythmicity and shift to other electrodes, by moving the head, implied that this second spike pattern was a heart beat artefact which originated from the mother.

The girl was diagnosed with cryptogenic localisation-related epilepsy in the bilateral temporal and frontal lobes and received anticonvulsant treatment.

Discussion

EEG with simultaneous ECG and video recording is important in the evaluation of loss of consciousness. It can be helpful in the differential diagnosis of cardiac and cerebral dysrhythmias. Although the EEG is aimed at recording cerebral activity, signals can be recorded as artefacts originating from various sources.

ECG artefacts are quite common and are easily recognized by their rhythmicity, regularity and coincidence with the ECG channel. This recognition becomes more difficult when cerebral abnormal activity (*e.g.* epileptiform activity) is mixed with EEG artefacts. The artefacts can than be mistaken for epileptiform activity. The QRS-complex, which represents the electrical component of the contraction of the heart, is seen slightly ahead of the pulse waves (with a 200-300 millisecond delay) (Brittenham, 1990). Small artefacts reflect mainly the R wave of the ECG, which appear maximally over the left posterior head regions as positive sharply contoured waveforms. They appear over the right anterior head region as a negative polarity with lower amplitude (Fisch, 1999). Larger artefacts may reflect additional components of the ECG. Their intermittent occurrence in the absence of an ECG may give the impression of abnormal posterior sharp waves or rhythmic delta activity. These artefacts are more difficult to differentiate when they do not coincide with the ECG, as was the case in this EEG recording. Simultaneous video recording is very useful to differentiate artefact from cortically generated elements of the graph.

One of the most common pitfalls of EEG interpretation is to mistakenly identify non-cerebral potentials as originating from the brain. ECG artefacts may disrupt the background activity in the EEG to resemble epileptiform discharges. ECGs usually vary less in amplitude, contour, duration and location. It can be difficult to distinguish between heart beat artefacts and cerebral activity if the ECG beat is not monitored and when no simultaneous video is recorded, especially in an EEG with interictal epileptiform discharges and ECG artefacts not resulting from the patient. We therefore endorse simultaneous video and EEG recording. □

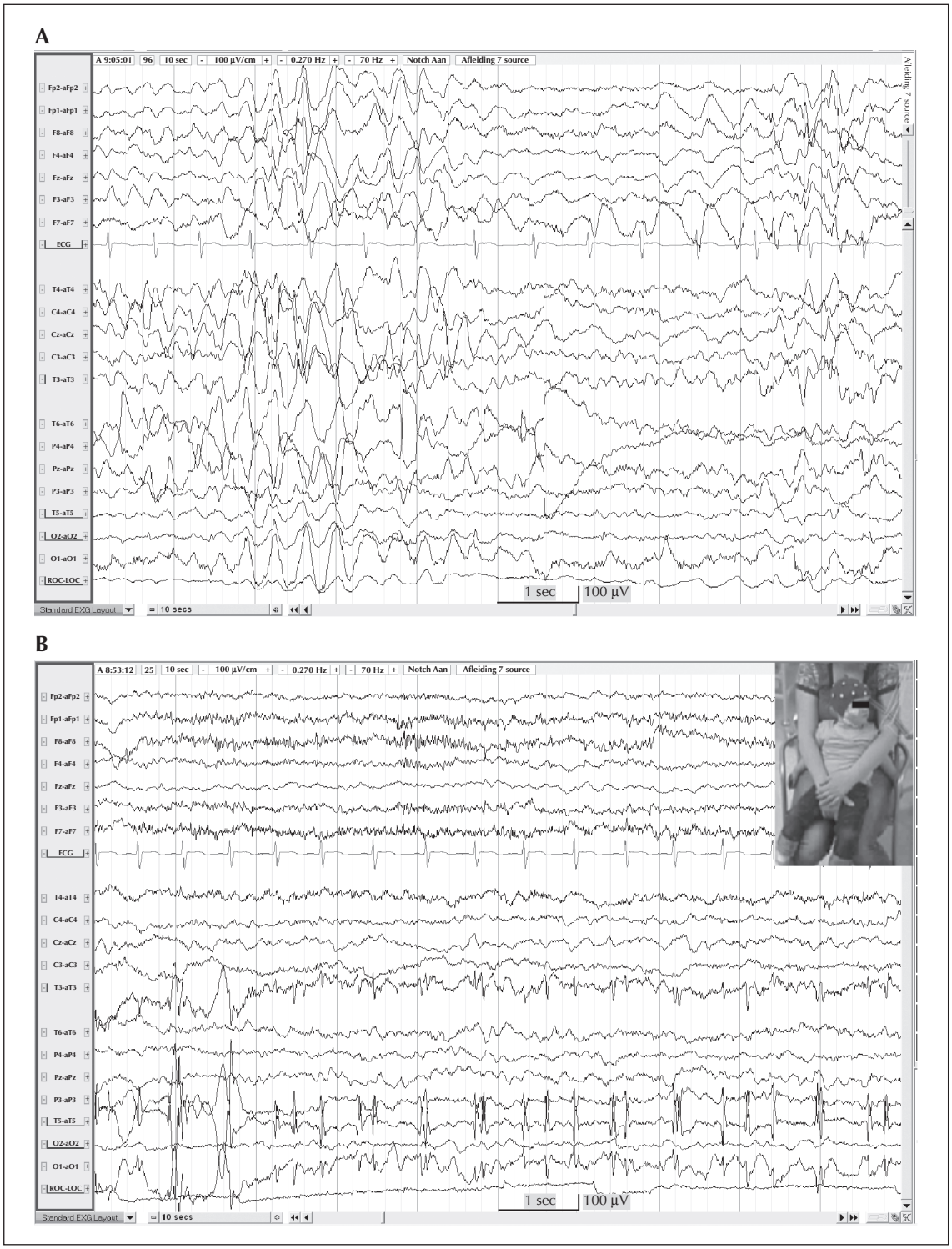

Figure 1. **A**) Interictal EEG in the source montage, calibration 100 µV, 1 second. Pattern of generalised 3-Hertz slow spike-wave discharges with an anterior maximum, not associated with clinical manifestations.
B) Interictal EEG in the source montage, calibration 100 µV, 1 second.
Rhythmic artefacts may be confused with ictal patterns; monomorphic rhythmic spikes of high amplitude with a clear difference in frequency and rhythmicity between the first and second spike at the T3, T5 and O1 electrodes. Each first spike occurred consistently with the R wave in the ECG. This pattern mimicked the frequency of slow spike-wave discharges in the left midtemporal area.

Disclosure.
None of the authors has any conflict of interest or financial support to disclose.

Legend for video sequence

Rhythmic artefacts may be confused with ictal patterns; monomorphic rhythmic spikes of high amplitude with a clear difference in frequency and rhythmicity between the first and second spike at the P3, O1 and T3 electrodes. Each first spike occurred consistently with the R wave in the ECG. This pattern mimicked the frequency of slow spike-wave discharges in the left midtemporal area.

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