DEPARTMENTS

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A Modern Artifact in the Sleep Laboratory

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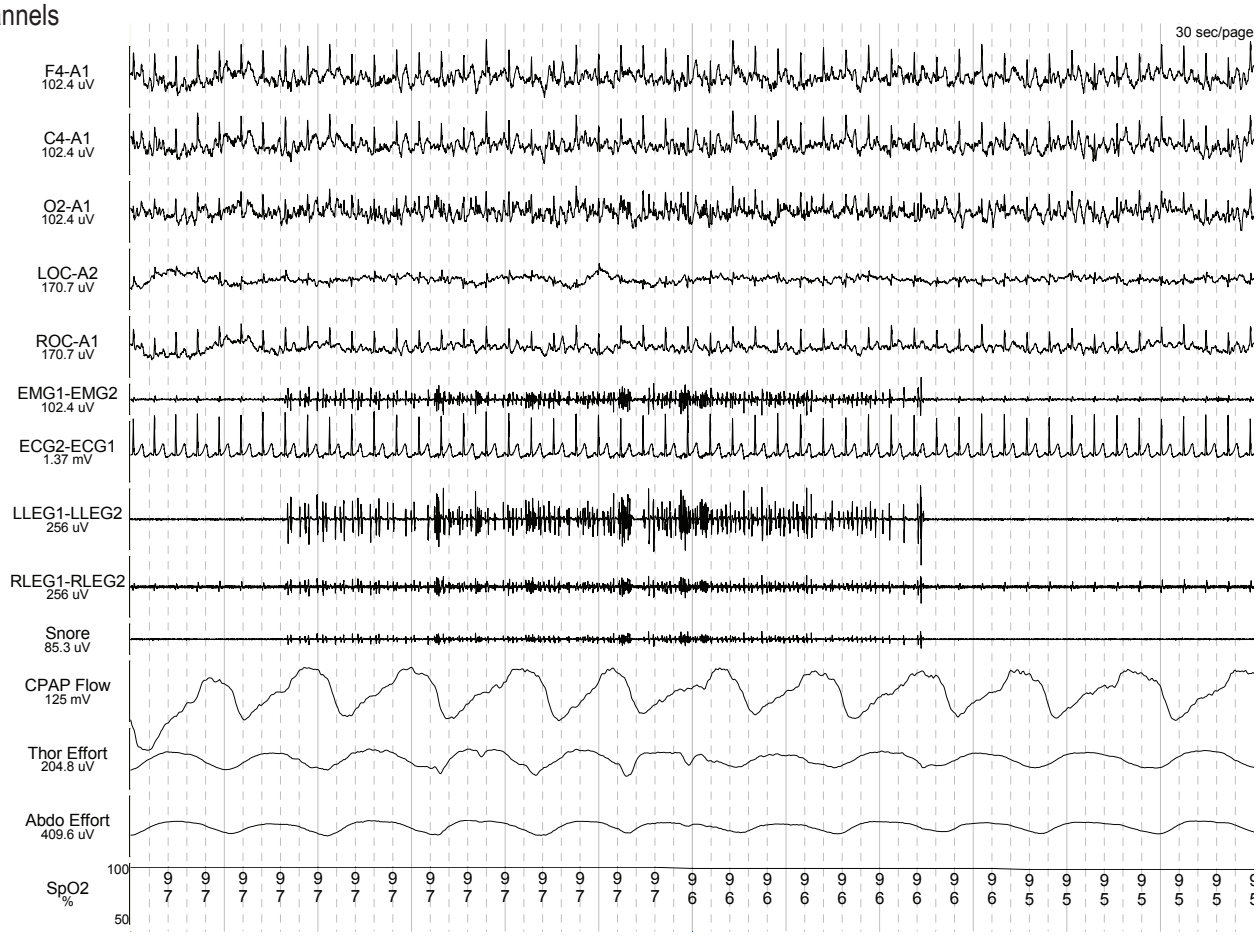
After reviewing this article, readers should be able to identify a novel modern artifact seen in the sleep laboratory. A 34-year-old woman was referred to the sleep laboratory for a continuous positive airway pressure (CPAP) titration to treat sleep apnea. When the polysomnogram (PSG) was reviewed, a novel pattern was observed which was most obvious in the electromyography (EMG), audio snore channels, and electroencephalogram (EEG) (**Figure 1A**).

The pattern was composed of 100-μV low frequency (5-9 Hz) sharply contoured waveforms with intermittent high frequency (20-50 Hz) sinusoidal waves. They occurred throughout the night and lasted approximately 1-20 sec. Review of the audio recording revealed an intermittently rhythmic sound during the discharges.

Q: What is the cause of these abnormal traces in the PSG?

Figure 1A—30-second epoch of polysomnography including a burst of interference seen most clearly in the EMG and snore channels



Interference in the EEG (F4-A1, C4-A1, O2-A1) is also observed. An incidental cardiac artifact is noted in the EEG. LOC-A2, ROC-A1: electrooculography. EMG1-EMG2: chin electromyogram. ECG2- ECG1: electrocardiogram. LLEG1-LLEG2, RLEG1-RLEG2: leg electromyogram. Snore: microphone. CPAP flow: continuous positive airway pressure flow. Thor effort, Abdo Effort: chest/abdomen respiratory inductance plethysmography, SpO_2%, pulse oximetry.

A: Interference due to mobile phone activity.

Before sleeping, the patient placed her mobile phone (iPhone, Apple Inc.) approximately 12 inches away from the headbox (**Figure 1B**). Over the night, several bursts of interference were seen, which were prominent in the EEG, EMG, and audio channels because the artifact falls within the filtered range. These patterns also occurred in the ECG, but were less apparent as the ECG sensitivity is typically set a few orders of magnitude less than the EEG or EMG. Typically, interference is easily detected when present in multiple channels simultaneously. An incidental cardiac artifact is noted in the EEG, which could be reduced by referencing the EEG to linked mastoids (A1+A2).

In this case, interference did not correspond to phone calls or received messages and could have been caused by the phone's intermittent communication with its provider.

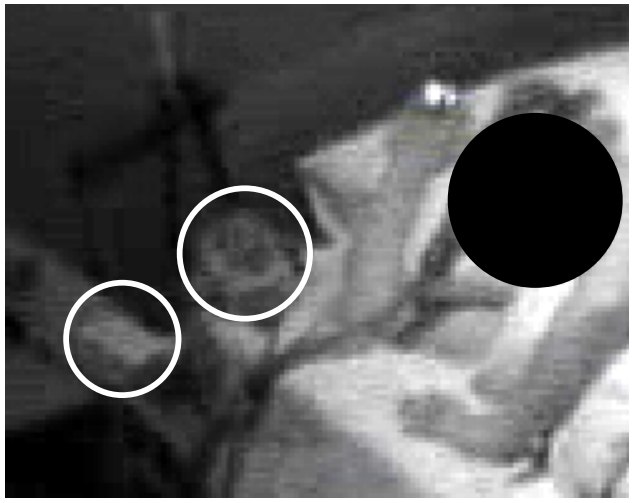
This finding can lead to clinical confusion for clinicians and technologists. The staging of the sleep may be misinterpreted because the frequency of the interference in the EEG can mimic spindles (11-16 Hz). Therefore, short bursts may bias towards scoring stage N2 sleep. The high amplitude, short bursts of activity can mimic elevated tone in REM sleep as is observed in the REM sleep behavior disorder. In a recent *Emergency Medical Journal* article,[1] authors described a case of a phone causing interference in an ECG that may have been confused for a malfunctioning pacemaker. Interference may also obscure significant events. In **Figure 1A**, approximately 18 seconds of a 30-second epoch were masked. During periods of interference like this brief epileptiform activity, transient EMG activity, or cardiac arrhythmias may occur.

Mobile device interference with medical equipment has been investigated to determine safety. As technology improves, interference with equipment is becoming less of a concern. In a 2004 study,[2] investigators tested a variety of mobile devices. In older equipment, at distances of 17-32 inches, they observed significant interference, though newer technologies are less problematic. ECG and EEG were most susceptible to mobile device interference. Other recent publications have noted that cellphones close to a person's head can delay objectively measured sleep onset latency[3] and also alter sleep architecture.[4] This effect may be modulated by cellphone low-frequency signals that are in the same range as the visible human EEG that define sleep staging. In overnight or daytime PSG studies, patients are more likely to bring other devices (laptops, tablets, etc.) into the recording environment to occupy themselves before, or between, sleep periods. The effect of these technologies on medical equipment is unknown, and could conceivably interfere at short distances.

CLINICAL PEARLS FOR MOBILE PHONE INTERFERENCE

- Clinicians and technicians should be aware of potential interference
- Simultaneous abnormal activity across multiple channels can help identify this source of interference, and technical artifacts in general. Reviewing audio and video recordings can also help provide important clues.
- To minimize confounding results, patients should be instructed to keep mobile devices at least 32 inches away from laboratory equipment.
- With rapidly changing technology, there are many potential sources of interference from consumer devices.

Figure 1B—Patient's mobile phone (circled on left) is placed about 12 inches from the PSG headbox (circled on right).



CITATION

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