Interictal spikes

Interictal spikes are brief (< 250 milliseconds), morphologically defined events observed in the EEGs of patients predisposed to spontaneous seizures of focal onset. The spikes are generated by the synchronous discharges of a group of neurons in a region referred to as the epileptic focus. While some would argue that the neural network that generates spikes is not always identical to the network that generates seizures, interictal spikes are so highly correlated with spontaneous seizures that their presence is used to support the diagnosis of epilepsy [1].

McLeod et al. compared estimated epileptic source localizations from 5 sleep-wake states (SWS): wakefulness (W), rapid eye movement sleep (REM), and non-REM 1-3.

Electrical source localization (sLORETA) of interictal spikes from different SWS on surface EEG from the epilepsy monitoring unit at spike peak and take-off, with results mapped to individual brain models for 75% of patients. Concordance was defined as source localization voxels shared between 2-5 SWS, and discordance as those unique to 1 SWS against 1-4 other SWS.

563 spikes from 16 prospectively recruited focal epilepsy patients across 161 day-nights. SWS exerted significant differences at spike peak but not take-off. Source localization size did not vary between SWS. REM localizations were smaller in multifocal than unifocal patients (28.8% vs. 54.4%, p=0.0091). All 5 SWS contributed about 45% of their localizations to converge onto 17.0±15.5% voxels. Against any one other SWS, REM was least concordant (54.4% vs. 66.9%, p=0.0006) and most discordant (39.3% vs. 29.6%, p=0.0008). REM also yielded the most unique localizations (20.0% vs. 8.6%, p=0.0059).

REM was best suited to identify candidate epileptic sources. sLORETA proposes a model in which an “omni-concordant core” of source localizations shared by all 5 SWS is surrounded by a “penumbra” of source localizations shared by some but not all SWS. Uniquely, REM spares this core to “move” source voxels from the penumbra to unique cortex not localized by other SWS. This may reflect differential intra-spike propagation in REM, which may account for its reported superior localizing abilities [2].

A study of Lambert et al.investigated whether interictal hippocampal spikes during sleep would impair long-term memory consolidation.

They prospectively measured visual and verbal memory performance in 20 patients with epilepsy investigated with stereoelectroencephalography at immediate, 30-min and 1-week delays, and studied the correlations between interictal hippocampal spike frequency during waking and the first cycle of non-rapid eye movement sleep and memory performance, taking into account the number of seizures occurring during the consolidation period and other possible confounding factors such as age and epilepsy duration.

Retention of verbal memory over 1 week was negatively correlated with hippocampal spike frequency during sleep, whereas no significant correlation was found with hippocampal interictal spikes during waking. No significant result was found for visual memory. Regression tree analysis showed that the number of seizures was the first factor that impaired verbal memory retention between 30min and 1 week. When the number of seizures was below 5, spike frequency during sleep higher than 13/min was associated with impaired memory retention over 1-week.

The results show that activation of interictal spikes in the hippocampus during sleep and seizures specifically impairs long-term memory consolidation. We hypothesize that hippocampal interictal spike [3]

1)

Engel J. Seizures and Epilepsy. Philadelphia, PA: FA Davis; 1989.

2)

McLeod GA, Abbasian P, Toutant D, Ghassemi A, Duke T, Rycyk C, Serletis D, Moussavi Z, Ng MC. Sleep-wake states change the interictal localization of candidate epileptic source generators. Sleep. 2022 Mar 13:zsac062. doi: 10.1093/sleep/zsac062. Epub ahead of print. PMID: 35279715.

3)

Lambert I, Tramoni-Negre E, Lagarde S, Roehri N, Giusiano B, Fonseca AT, Carron R, Benar CG, Felician O, Bartolomei F. Hippocampal interictal spikes during sleep impact long-term memory consolidation. Ann Neurol. 2020 Apr 12. doi: 10.1002/ana.25744. [Epub ahead of print] PubMed PMID: 32279329.