Ictal direct current shift

An ictal direct current (DC) shift is a phenomenon observed in the brains of individuals during certain types of epileptic seizures. It refers to a sustained change in the electrical potential across brain tissue, typically characterized by a slow and prolonged shift in voltage that occurs during a seizure.

During a seizure, there is an abnormal and excessive synchronization of neuronal activity in the brain. This synchronized activity can lead to a significant increase or decrease in electrical potential, resulting in the ictal DC shift. This shift can be observed in electroencephalography (EEG) recordings as a slow, persistent change in voltage over a period of seconds to minutes, differentiating it from the more rapid and rhythmic activity seen in typical epileptic EEG patterns.

The ictal DC shift is of clinical interest because it can help in the identification and localization of the seizure focus (the area where the seizure originates) in patients with epilepsy. It may provide valuable information for epilepsy diagnosis and surgical planning for individuals with drug-resistant seizures. Monitoring and analyzing the ictal DC shift can aid in understanding the pathophysiology of seizures and guiding treatment decisions for epilepsy patients.

Ictal direct current shifts (icDCs) and ictal high-frequency oscillations (icHFOs) have been reported as surrogate markers for better surgical outcomes in epilepsy surgery. icDCs have been classified into two types: rapid and slow development. icDCs have been investigated with a time constant of 10 s (TC10s); however, many institutes use electroencephalography with a time constant of 2 s (TC2s). This study aimed to evaluate whether icDCs can be observed adequately with TC2s; moreover, it examined the relationship between the resected core area of icDCs or icHFOs and surgical outcomes, the occurrence rate of each type of icDCs, and the relationship between each type of icDCs and pathology.

Methods: Twenty-five patients with intractable focal epilepsy were analyzed retrospectively. icDCs and icHFOs were defined according to common metrics. The amplitude of icDCs was defined at >200 µV and even <200 µV. The two electrodes producing the most prominent icDCs and icHFOs were defined as core electrodes. The correlation between the resected core electrode area and degree of seizure control after surgery was analyzed. icDCs were classified into two types based on a peak latency value cutoff of 8.9 s, and the occurrence rates of both patterns were investigated.

Results: icDCs (142/147 seizures [96.6%]) and icHFOs (135/147 seizures [91.8%]) occurred in all patients (100%). Compared with the amplitude of icDCs with TC10s reported in previous studies, the amplitude of icDCs with TC2s was attenuated in the current study. A significant positive correlation was observed between the resected core electrode area and the degree of seizure control in both icDCs and icHFOs. A rapid development pattern was observed in 202 of 264 electrodes (76.5%).

Significance: Similar to icDCs with TC10s, those with TC2s were observed adequately. Furthermore, favorable outcomes are expected using TC2s, which are currently available worldwide [1)]

This study contributes to our understanding of how icDCs and icHFOs can be observed and classified, their relationships with surgical outcomes, and the practicality of using TC2s in clinical settings. These findings may guide epilepsy surgeons in identifying the most effective targets for resection and improving patient outcomes in epilepsy surgery.

[1]

Izumi M, Kobayashi K, Kajikawa S, Kanazawa K, Takayama Y, Iijima K, Iwasaki M, Okahara Y, Mine S, Iwadate Y, Ikeda A. Focal ictal direct current shifts by a time constant of 2 seconds were clinically useful for resective epilepsy surgery. Epilepsia. 2023 Oct 31. doi: 10.1111/epi.17782. Epub ahead of print. PMID: 37905469.