

Glia, DC shifts/red slow, and epilepsy



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Clinical EEG provides us with diagnostic information of epileptogenicity by epileptiform discharges, i.e., spikes, sharp waves, which reflect the paroxysmal depolarization shifts (PDS) in the epileptic neurons. Currently advanced technology has enabled us to record wide-band EEG: direct current (DC) shifts and high frequency oscillation (HFO). The both conditions could widen the neurophysiological definition of epileptogenicity.

Ictal DC shifts was recorded by using a DC amplifier in 1960s with technical difficulty, but recently is by applying very small low frequency filter (0.016Hz) of an AC amplifier which has the large input impedance more than 200 mega-ohm without difficulty in patients with invasive electrodes (Ikeda et al., 1996,1997,1999, 2008). It could reflect the massive, synchronized paroxysmal depolarization of the neurons in the epileptogenic area, and thus also represents associated depolarization of the glia. It could be regarded as the surrogate markers of the core epileptogenicity in human epilepsy regardless of the etiology.

Once HFO is thought to highly reflect epileptogenicity in human epilepsy, we have investigated both ictal DC shifts and HFO simultaneously in patients with intractable partial epilepsy by means of subdural electrodes (Imamura et al., 2011; Kanazawa et al., 2015; Daifu et al., 2016). Ictal DC shifts occurred earlier than or as early as ictal HFO significantly. It could suggest more active role of glia in not only generating DC shifts but also presumably in ictogenesis. Namely, potassium homeostasis with Kir4.1 channel activity in the astrocytes as the functional syncytium may play an important role not only after seizure but also immediately before seizure generation. Glia may be an also a target of the drug to suppress the seizures and an potential index of epileptogenic area from both electrophysiological and neuroimaging points of view. Furthermore, beyond both ictal DC and HFO, interictal state of DC or slow shifts and HFO in combination may be a next concern, because interictal information still have a room to delineate the epileptogenicity, as previously raised but failed concept of "red spike" as opposed to "green- and yellow spike".
