How does the brain generate HFOs – basic science explained for clinicians

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High-frequency oscillations are considered a new biomarker of epileptogenic tissue generating spontaneous and repeated seizures. This localizing ability led to their rapid introduction into clinical practice to increase the information yield of presurgical examination, to better delineate resection margins and improves the outcome of epilepsy surgery. The ability to generate oscillatory activity even at high frequency is one of the main features of the human brain. HFOs, however, represent a heterogeneous group of brain oscillations of various morphology and with frequency ranging from 80 Hz to ultrafast oscillations >1000 Hz. While certain oscillations are associated with physiological brain function others are only present in an epileptic brain. Heterogeneity of oscillations can be also observed on cellular and network levels. Physiological oscillations require precise timing and coordinated interplay between interneurons and principal cells. In contrast, pathological oscillations reflect synchronous action potential firing of small groups of principal cells and their properties are shaped by altered network connectivity, loss of interneuronal control etc. Understanding the mechanisms which underlie the genesis of normal and pathologic HFOs helps to elucidate the abnormal organization and function of epileptic tissue. Insight into their neuronal mechanisms also brings fundamental insights into the mechanisms which are responsible for seizure initiation or for prolonged susceptibility of the brain tissue to generate seizures.