**Supplemental Methods**

**LCP-TF µECoG Arrays**

We measured the broadband noise in-vitro on LCP-TF arrays prior to sterilization for each intraoperative recording. We used the same recording headstages and acquisition system as described in the Intraoperative Data Collection section of the Methods. We submerged the LCP-TF recording contacts in a conductive saline solution connected to the recording system ground. RMS noise was calculated as the standard deviation of the signal decimated to 2kHz. Example noise amplitude results are shown for the Au microcontact array (mean = 3.18 µVrms; standard deviation =1.28 µVrms) used to record from S4 and the PtIr microcontact array (mean = 2.62 uVrms; standard deviation = 0.28 uVrms) used to record from S7 (Supplemental Figure 13). Subjects S1-S6 were recorded using arrays with Au microcontacts and subjects S7&S8 were recorded using arrays with PtIr microcontacts. All microcontacts were 200 µm in diameter.

**HFO Detection and Artifact Rejection**

We implemented the Staba algorithm in RippleLab software (version 3, accessed July 2020, https://github.com/BSP-Uniandes/RIPPLELAB/) by first bandpass filtering each cleaned recording between 80-250 Hz for ripples and 250 – 600 Hz for fast ripples (Chebyshev Type II infinite impulse response filter, applied forward and reverse) and identifying time segments in which the sliding root mean square (RMS) of the filtered signal surpassed a threshold of five standard deviations above the mean for at least six milliseconds.36,37 We retained events if the rectified signal had at least six peaks passing a threshold of three standard deviations above the mean. We combined any oscillations occurring within 10 ms of each other on the same contact as one HFO.

Sharp transients and spike-like waveforms are non-band limited and therefore can result in large ringing artifacts in the HFO frequency range when filtered.38,39 These are often falsely detected as HFOs by energy thresholding algorithms such as the Staba detection method. 38,39 Our 150 µV/ms threshold for reducing the number of false HFO detections resulting from sharp transients was set by visual review of a subset of HFO detections from our µEcoG recordings and eliminated only the sharpest events. Similar to other reported derivative thresholding criteria, we found this step greatly reduced the number of false HFO detections resulting from ringing artifacts when filtering sharp transients.39 For visual review of HFO events, time-frequency plots were generated using the Morse Wavelet transform as suggested by a previous study reviewing various time-frequency analyses best suited for visual identification of HFO events.43 To account for 1/f power attenuation, the wavelet transform was applied to the first derivative of the unfiltered signal to ensure that higher frequency activity was visible in the time-frequency plots.45 Elimination of spike-like waveforms during visual review could complicate the identification of coincident ripple-on-spike events. We differentiated HFOs coincident with, rather than resulting from the filtering of, spike-like waveforms by the presence of a clear HFO in the raw signal and/or a spectral ‘island’ independent from the broader signature of the spike in the time frequency plots (Figure 2a-c).38,39,45

**Cross Covariance Analysis**

When measuring HFO event size, we used covariance between HFOs and surrounding activity in the 80-250 Hz and 250 – 600 Hz ranges for ripples and fast ripples, respectively, as a method to account for diffuse high-frequency activity occurring on neighboring microcontacts that are part of the same event but may have fallen below detection threshold. To start, we grouped detected HFOs in time. To form these groups, we sorted the HFOs across all channels in time and identified the first occurring HFO. We added to the group any other HFOs detected across the array within 10 ms of the end of the initial HFO, the same time window used in the automated detection algorithm. We then calculated a geometric center point between the contact locations of HFOs in each group. We used the HFO which occurred on the channel nearest the geometric center as the central HFO from which to measure the radial size of the HFO group. We computed the 0-lag cross covariance between the central ripple or fast ripple HFO and the bandpass filtered (80 – 250 Hz and 250 – 600 Hz for ripples and fast ripples, respectively) signal on all other contacts across the array. We computed cross covariance over the duration of the central HFO +/- 10 ms. For each HFO group, we plotted the absolute values of the cross covariance against the Euclidian distance of each contact across the full array from the central HFO contact (Figure 4a,b). We then moved ahead in time to the next HFO group and repeated this analysis.

We also observed that a small number of multicontact events were not well characterized by the exponential model. Therefore, we also fit a linear model to each covariance over distance curve:

$$Covariance=a+ (b\*Distance)$$

We compared the goodness of fit between the two models by the root mean square error. We discarded from further spatial analysis the events for which the root mean square error was higher for the linear model than the exponential model.