

# High frequency oscillations and high frequency functional network characteristics in the intra-operative electrocorticogram in temporal lobe epilepsy

*W. Zweiphenning<sup>1</sup>, M. van 't Klooster<sup>1</sup>, E. van Diessen<sup>2</sup>, N. van Klink<sup>1</sup>, G. Huiskamp<sup>1</sup>, T. Gebbink<sup>1</sup>, F. Leijten<sup>1</sup>, P. Gosselaar<sup>1</sup>, W. Otte<sup>1,3</sup>, C. Stam<sup>4</sup>, K. Braun<sup>2</sup>, M. Zijlmans<sup>1,5</sup>*

<sup>1</sup> Brain Center Rudolf Magnus, Department of Neurology and Neurosurgery, UMC Utrecht, the Netherlands

<sup>2</sup> Brain Center Rudolf Magnus, Department of Pediatric Neurology, UMC Utrecht, the Netherlands

<sup>3</sup> Biomedical MR Imaging and Spectroscopy Group, Image Sciences Institute, UMC Utrecht, the Netherlands

<sup>4</sup> Department of Clinical Neurophysiology, VU University Medical Center, Amsterdam, the Netherlands

<sup>5</sup> SEIN – Stichting Epilepsie Instellingen Nederland, Heemstede, the Netherlands

## ABSTRACT

**Rationale:** HFOs, especially fast ripples (250-500Hz), are believed to represent tissue with pathologically increased functional interneuronal connections. Network studies on focal epilepsy data show pathological highly connected nodes, but areas with FRs seem isolated in the theta and gamma band networks. We investigated the relation between HFOs and functional networks in the high frequency bands.

**Methods:** We marked FRs, ripples and spikes in pre-resection ioECoG of TLE patients. We assessed connectivity in four event-free epochs using the phase lag index and eigenvector centrality per channel in the FR, ripple, gamma and theta band. We compared numbers of events and connectivity measures between channels that were/(not) resected, and channels with/(out) events using paired T-tests. We related percentages of events to connectivity measures using linear mixed models.

**Results:** Eight patients had FRs (mean:10/min), twelve patients ripples (M:41/min), and eleven patients spikes (M:180/min). We found higher FR-band PLI and EC in resected channels ( $p=0.04, p=0.06$ ), and a trend towards higher FR-band PLI in channels with spikes ( $p=0.07$ ). Congruently, we found a positive association between the percentage of spikes and FR-band PLI ( $p = 0.05$ ). We found lower gamma-band PLI and EC in channels with events ( $p<0.05$ ). We found a negative association between the percentage of events and gamma-band PLI and EC ( $p<0.01$ ).

**Discussion:** Similar to previous network studies, we found functional isolation within the gamma band of areas showing epileptiform events. However, we found a tendency towards high connectivity within the FR-band for channels suspected to cover the epileptogenic area. These findings were based upon epochs without epileptiform events.