

Computational analysis of interneuronal activity during abnormal network synchronisation

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This collaborative project aims at a clarification of the role in interneurons in the initiation of, and transition from interictal to ictal activity in focal epilepsies. For this purpose, both electrophysiological investigations in acute in vitro animal models of focal epilepsy and recordings from human epileptogenic tissue will be used to obtain data for determining the role of interneurons in realistic network models of focal epilepsy.

Traditionally, interneurons have been regarded as network elements with primarily inhibiting and thus anti-epileptic functions. During the last years, a different concept of interneurone function has emerged, which now regards these cells as critical elements in the synchronisation of extended neuronal networks, assigning to them both an inhibitory, as well as excitatory and/or synchronising role. Which of these functions predominates is very likely a function of interneurone-type, localisation, network integration, the general activity level, and – not least – the degree of tissue alteration as a consequence of disease. The prevailing function of the diverse interneurons thus is subject to dynamic fluctuations.

In this project, the role of inhibitory interneurons for generation of interictal and ictal epileptic activity will be assessed by three complementary approaches:

(1) In-vitro electrophysiological investigations in acute animal models of focal epilepsy (Köhling, University of Rostock; physiologie.med.uni-rostock.de), both in normal and chronically epileptic tissue, to determine the role of different types of interneurons at initiation of epilepsy and interictal-ictal transitions.

(2) In-vitro electrophysiological investigations of human slices of neocortical focal epilepsies (focal cortical dysplasia, Hefft & Schulze-Bonhage, Epilepsy Center, University Hospital Freiburg; www.epi-freiburg.de) as well as in a model of cortical dysplasia aiming at a detailed biophysical description of the main properties of inhibitory synaptic transmission in the epileptogenic tissue

(3) Modelling studies based on data from parts (1) and (2) to establish network models of interneuronal function for epileptogenesis (Aertsen, Bernstein Center for Computational Neuroscience, Freiburg; www.bccn-freiburg.de).

