

### **POSTER PRESENTATION**

**Open Access** 

# Modeling the effects of neuronal morphology on dendritic chloride diffusion and GABAergic inhibition

Namrata Mohapatra<sup>1\*</sup>, Fidel Santamaria<sup>2</sup>, Peter Jedlicka<sup>1</sup>

From The Twenty Third Annual Computational Neuroscience Meeting: CNS\*2014 Québec City, Canada. 26-31 July 2014

Gamma-aminobutyric acid receptors (GABAARs) are ligand-gated chloride (Cl<sup>-</sup>) channels which mediate the majority of inhibitory neurotransmission in the CNS. Spatiotemporal changes of intracellular Cl<sup>-</sup> concentration alter the concentration gradient for Cl<sup>-</sup> across the neuronal membrane and thus affect the current flow through GABAARs and the efficacy of GABAergic inhibition. However, the impact of complex neuronal morphology on Cl<sup>-</sup> diffusion and the redistribution of intracellular Cl is not well understood. Recently, computational models for Cl<sup>-</sup> diffusion and GABA<sub>A</sub>R-mediated inhibition in realistic neuronal morphologies became available [1-3]. Here we have used computational models of morphologically complex dendrites to test the effects of spines on Cl diffusion. In all dendritic morphologies tested, spines slowed down longitudinal Cl<sup>-</sup> diffusion along dendrites and decreased the amount and spatial spread of synaptically evoked Cl<sup>-</sup> changes. Spine densities of 2-10 spines/ um decreased the longitudinal diffusion coefficient of Clto 80-30% of its value in smooth dendrites, respectively. These results suggest that spines are able to limit shortterm ionic plasticity [4] at dendritic GABAergic synapses.

#### Acknowledgements

Supported by the NSF/BMBF (US-German Collaboration in Computational Neuroscience, No. 01GQ1203A).

#### Authors' details

<sup>1</sup>Institute of Clinical Neuroanatomy, Neuroscience Center, Goethe-University, Frankfurt, Germany. <sup>2</sup>Biology Department and Neurosciences Institute,The University of Texas at San Antonio, San Antonio, USA.

Published: 21 July 2014

<sup>1</sup>Institute of Clinical Neuroanatomy, Neuroscience Center, Goethe-University, Frankfurt, Germany

Full list of author information is available at the end of the article

#### References

- Jedlicka P, Deller T, Gutkin BS, Backus KH: Activity-dependent intracellular chloride accumulation and diffusion controls GABA<sub>A</sub> receptor-mediated synaptic transmission. *Hippocampus* 2011, 21:885-898.
- Doyon N, Prescott SA, Castonguay A, Godin AG, Kröger H, Koninck YD: Efficacy of synaptic inhibition depends on multiple, dynamically interacting mechanisms implicated in chloride homeostasis. PLoS Comput Biol 2011, 7(9):e1002149.
- Lewin N, Aksay E, Clancy CE: Computational modeling reveals dendritic origins of GABA<sub>A</sub>-mediated excitation in CA1 pyramidal neurons. PLoS One 2012 7(10):e47250
- Raimondo JV, Markram H, Akerman CJ: Short-term ionic plasticity at GABAergic synapses. Front Syn Neurosci 2012, 4:5.

doi:10.1186/1471-2202-15-S1-P138

Cite this article as: Mohapatra *et al.*: Modeling the effects of neuronal morphology on dendritic chloride diffusion and GABAergic inhibition. *BMC Neuroscience* 2014 **15**(Suppl 1):P138.

## Submit your next manuscript to BioMed Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at www.biomedcentral.com/submit





<sup>\*</sup> Correspondence: mohapatra@em.uni-frankfurt.de